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ENHANCING BUSINESS PROCESS EFFICIENCY UNDER THE GREEN ENERGY TRANSITION: INSTITUTIONAL AND ECONOMIC DRIVERS OF ENERGY SAVING IN UKRAINE

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ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ БІЗНЕС-ПРОЦЕСІВ В УМОВАХ ПЕРЕХОДУ НА ЗЕЛЕНУ ЕНЕРГЕТИКУ: ІНСТИТУЦІЙНІ ТА ЕКОНОМІЧНІ РУШІЙНІ ДРАЙВЕРИ ЕНЕРГОЗБЕРЕЖЕННЯ В УКРАЇНІ

У статті досліджено сутність, значення та сучасні трансформації ефективності бізнес-процесів як ключового чинника забезпечення конкурентоспроможності підприємств в умовах переходу до зеленої енергетики та реалізації Європейського зеленого курсу. Обґрунтовано, що підвищення ефективності бізнес-процесів є критично важливим для адаптації підприємств до викликів декарбонізації, енергозбереження та цифрової трансформації, а також для забезпечення стійкого розвитку в умовах глобальних екологічних і економічних змін. Доведено, що інтеграція цифрових технологій, механізмів ІТ-управління та інституційно-економічних інструментів енергозбереження сприяє оптимізації ресурсного використання, зниженню витрат та підвищенню продуктивності діяльності підприємств.

Розкрито структуру управління бізнес-процесами в контексті зеленої трансформації, яка охоплює фінансово-економічні, ресурсно-виробничі, організаційні та інтеграційні компоненти, кожен з яких відіграє важливу роль у формуванні ефективної моделі функціонування підприємства. Окреслено основні механізми підвищення ефективності бізнес-процесів, зокрема автоматизацію операцій, оптимізацію робочих потоків, удосконалення координаційних механізмів у ланцюгах постачання, впровадження цифрових платформ та розвиток систем управління знаннями. Особлива увага приділяється ролі ІТ-управління, яке забезпечує узгодженість між бізнес-цілями та цифровими інструментами, а також виступає важливим драйвером створення доданої вартості.

Проаналізовано вплив глобальних трендів декарбонізації, децентралізації та діджиталізації на трансформацію бізнес-процесів, а також визначено ключові інституційні та економічні бар'єри впровадження енергоефективних рішень в Україні, зокрема недосконалість регуляторного середовища, обмеженість інвестиційних ресурсів та інерційність управлінських підходів. Запропоновано шляхи їх подолання, що передбачають активізацію державної політики у сфері енергозбереження, розвиток

стимулюючих економічних інструментів, впровадження інноваційних технологій та підвищення рівня цифрових компетентностей персоналу.

У контексті формування зеленої економіки обґрунтовано необхідність переходу до системного управління бізнес-процесами на основі інтеграції принципів сталого розвитку, енергоефективності та цифровізації. Запропоновано методичний підхід до оцінювання ефективності бізнес-процесів, що базується на використанні інтегральних показників та дозволяє ідентифікувати проблемні зони й обґрунтувати управлінські рішення щодо їх оптимізації. Визначено, що ефективність бізнес-процесів у сучасних умовах виступає не лише інструментом підвищення продуктивності, але й стратегічною основою реалізації політики енергозбереження.

Доведено, що підвищення ефективності бізнес-процесів у поєднанні з інституційними та економічними механізмами енергозбереження є визначальним фактором забезпечення конкурентоспроможності підприємств України та їх інтеграції до європейського економічного простору. Окреслено перспективи подальших досліджень, зокрема розроблення інтегрованих моделей управління бізнес-процесами з урахуванням вимог зеленої трансформації та оцінювання ефективності впровадження енергоефективних технологій на рівні підприємств і галузей.

The essence, significance, and contemporary transformations of business process efficiency as a key factor in ensuring enterprise competitiveness under the conditions of the transition to green energy and the implementation of the European Green Deal are examined in the paper. It is substantiated that the enhancement of business process efficiency is critically important for enabling enterprises to adapt to the challenges of decarbonization, energy saving, and digital transformation, as well as for ensuring sustainable development in the context of global environmental and economic changes. It is demonstrated that the integration of digital technologies, IT governance mechanisms, and institutional

and economic instruments of energy saving is facilitated through the optimization of resource utilization, cost reduction, and the increase in enterprise productivity.

The structure of business process management in the context of green transformation is revealed, encompassing financial-economic, resource-production, organizational, and integration components, each of which is considered to play a significant role in shaping an effective enterprise operating model. The key mechanisms for improving business process efficiency are outlined, including the automation of operations, workflow optimization, enhancement of coordination mechanisms within supply chains, the implementation of digital platforms, and the development of knowledge management systems. Particular attention is paid to the role of IT governance, through which alignment between business objectives and digital tools is ensured, and which is recognized as a critical driver of value creation.

The impact of global trends such as decarbonization, decentralization, and digitalization on the transformation of business processes is analyzed. In addition, key institutional and economic barriers to the implementation of energy-efficient solutions in Ukraine are identified, including imperfections in the regulatory environment, limited investment resources, and the inertia of managerial approaches. Ways to overcome these barriers are proposed, including the intensification of state policy in the field of energy saving, the development of incentive-based economic instruments, the implementation of innovative technologies, and the enhancement of digital competencies of personnel.

In the context of the formation of a green economy, the necessity of transitioning to systemic business process management based on the integration of the principles of sustainable development, energy efficiency, and digitalization is substantiated. A methodological approach to evaluating business process efficiency is proposed, based on the use of integral indicators, through which problem areas are identified and managerial decisions aimed at their optimization are substantiated. It is determined that business process efficiency under modern

conditions is regarded not only as a tool for increasing productivity but also as a strategic foundation for the implementation of energy-saving policy.

It is proven that the improvement of business process efficiency, in combination with institutional and economic mechanisms of energy saving, is considered a decisive factor in ensuring the competitiveness of Ukrainian enterprises and their integration into the European economic space. Prospects for further research are outlined, including the development of integrated business process management models that take into account the requirements of green transformation, as well as the evaluation of the effectiveness of the implementation of energy-efficient technologies at the enterprise and sectoral levels.

Ключові слова: *бізнес-процеси; зелена енергетика; енергозбереження; декарбонізація; цифровізація; інституційні механізми; сталий розвиток; конкурентоспроможність; енергоефективність; ланцюги постачання; Європейський зелений курс.*

Keywords: *business processes; green energy; energy conservation; decarbonization; digitalization; institutional mechanisms; sustainable development; competitiveness; energy efficiency; supply chains; European Green Deal.*

Statement of the problem and its connection with practical tasks. The current transition towards a more digital and interconnected business world necessitates that modern enterprises enhance their efficiency in business processes. This is crucial because it allows them to remain competitive, agile and responsive to the ever-changing market demands. Organizations must embrace the latest technologies to improve their operations, reduce costs, and increase productivity. Automation of repetitive tasks, streamlining of workflows, and optimization of resource allocation can all contribute to achieving greater efficiency. Furthermore, businesses should focus on eliminating wasteful activities and improving their supply chain management systems to enhance their overall effectiveness. In order

to achieve these goals, companies must invest in training their workforce to become adept at using new technologies and emphasize the importance of continuous improvement in all aspects of their operations. Failure to enhance business process efficiency can lead to lost opportunities, reduced productivity and ultimately, failure to survive in a highly competitive business environment. Therefore, it is imperative for modern enterprises to prioritize this aspect of their business strategy during this transition period.

A green economy is defined as low carbon, resource efficient and socially inclusive. In a green economy, growth in employment and income are driven by public and private investment into such economic activities, infrastructure and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services. These green investments need to be enabled and supported through targeted public expenditure, policy reforms and changes in taxation and regulation.

The purpose of the paper. The aim of the study is to develop a theoretical and methodological framework for improving business process efficiency in modern enterprises within the context of the green energy transition, by substantiating institutional and economic mechanisms of energy saving, including IT governance, digitalization, and decarbonization tools, in order to enhance competitiveness and ensure sustainable development.

Analysis of recent research and publications. In today's rapidly evolving business environment, efficient business processes are crucial for modern enterprises to remain competitive and realize benefits of information systems [1]. The pressure for cost reductions and the demands of a global economy have necessitated greater operational effectiveness and efficiency within and across organizational boundaries [1]. The design and improvement of business processes has been a topic of research and practice for several decades, with various methods proposed since the 1990s. Different strategies can play a role when choosing a method for improvement, but a framework with 264 activities clustered in six stages could be used for improving processes [1]. The analysis and design of work

flows and processes is important for enhancing business process efficiency [1]. Radical overhaul of business processes is required to attain major business goals in modern enterprises [1]. Information technology has been identified as a key mechanism for enhancing business process efficiency, with effective communication being crucial in coordinating business processes across supply networks [1][2]. Visibility into supply chain activities is necessary for effective coordination and improved business process efficiency. The use of technology can improve coordination mechanisms and enhance business process efficiency, with coordination mechanisms playing a key role in this process [2]. Collaborative planning and forecasting are important coordination mechanisms for managing supply networks, and effective BPM and SCC practices lead to enhanced performance and collaborative benefits [2][3]. BPM improves both organizational performance and collaborative activities [3]. Work flow and process design should be done within and between organizations, with IT governance recognized as a panacea for ensuring effective and efficient IT operation in multi-business organizations. IT governance levers can significantly increase business process performance, which can be analyzed through the resource-based perspective, economic theory of complementarities, and relatedness concept [4].

The mechanisms for improving business processes in e-business are unique and differ from traditional business process improvement approaches.

In e-business, governance control mechanisms play a crucial role in improving performance among business process outsourcing (BPO) organizations [5]. The digitally enabled extended enterprise is viewed as a complex system of business processes, and its value creation mechanisms are better understood through the process component lens [6]. A study that viewed business processes as a complex system of interdependent processes found that IT governance mechanisms, including structures and relational mechanisms, could improve business process performance independently [4]. Decentralization enhances firm performance, but it does not significantly contribute to enhancing the effectiveness of coupled practices. Meanwhile, the focus in traditional business process

improvement approaches is mostly on improving efficiency through re-engineering processes and continual change mechanisms. The emphasis is on competence and process performance, rather than efficiency of business operations [1]. Coordination mechanisms and shared responsibilities among supply network members are critical to achieve efficient business processes [2]. The availability and dissemination of data across the organization can lead to better organizational performance and improved business processes [7]. Finally, IT governance mechanisms are effective in enhancing social performance in banks, where IT business value manifests as "business performance" [8].

Presentation of the main material of the study with a full justification of the obtained scientific results. To gauge business process efficiency in modern enterprises, multiple criteria and indicators need to be taken into account. This includes financial-economic, resource-production, external integration, and organizational criteria. Each enterprise has its own unique set of specifications, which should be considered while forming a list of indicators. By assessing the efficiency and effectiveness of business processes through these criteria and indicators, it is possible to monitor the current activities of an enterprise and evaluate its operations at any given moment [9]. The methodology enables the evaluation of the status of specific business processes as well as the enterprise's totality, allowing for the prioritization of management actions for necessary improvements [9]. The methodology also involves calculating average weighted, integral, and generic indicators of efficiency and effectiveness to identify problematic areas or bottlenecks in certain business processes. This way, corrective measures can be taken to improve overall process efficiency [9]. A methodology tool has even been presented for the analysis and evaluation of business processes for Ukrainian enterprises, emphasizing the universal applicability of these assessment methods across different regions and industries [9].

While transitioning towards greener energy, modern enterprises in Ukraine face several challenges, which need to be addressed for successful implementation. Efficient collection, development and processing of knowledge about the

environment are crucial for the enterprises to analyze their business process management jointly, and improve them based on the BPR conception and correlation and regression analysis for building a sustainable advantage against competitors [10][11].

Fig. 1 highlights the role of the state as a subject of energy policy. The attention is focused on the non-market aspects of the state behavior model. Along with the economic instruments of the energy policy (privatization of enterprises, the introduction of market relations between the energy sector, market pricing mechanisms), the state regulated the prices of fuel and energy resources, subsidized certain energy sectors, weakened competitive energy mechanisms markets for a long time. Such measures limited the opportunities for enterprises development and minimized the effectiveness of energy policy.

Given the specifics of the energy-economic factors' integration in the structure of the country's economy, the problems of transformation of the fuel and energy complex should be considered primarily through the lens of optimization and progressive development of its structure.

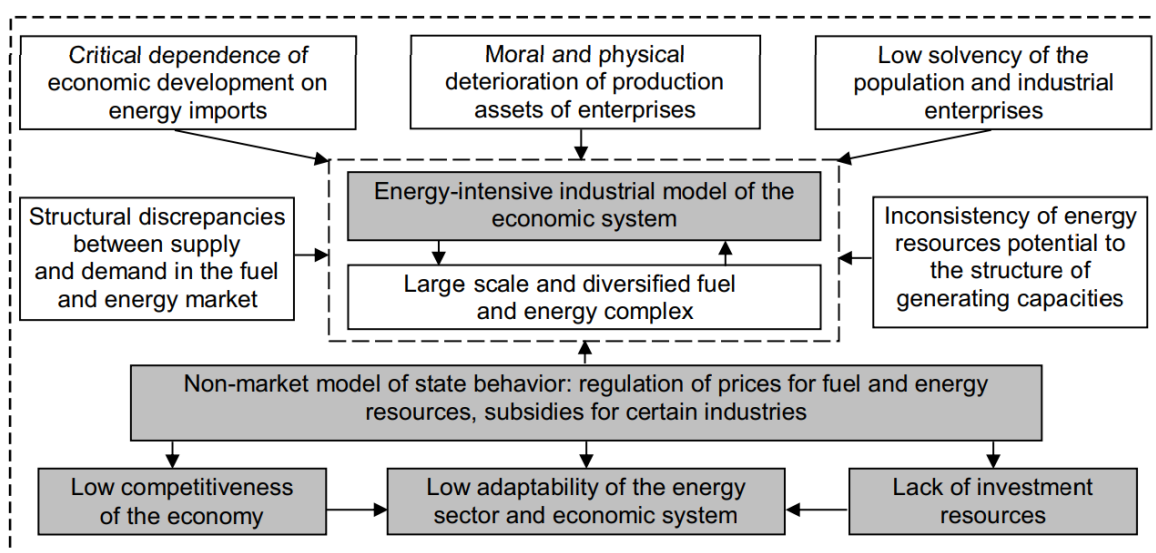


Figure 1. The problems of Ukraine's energy sector transformation

Source: formed by the authors

Of course The Russian invasion of Ukraine had a significant impact on the energy sector, resulting in a 43% drop in energy demand in 2022 compared to 2013 (Fig. 2). Achieving carbon neutrality necessitates a radical transformation of

the energy supply mix, emphasizing the importance of harnessing the potential of modern bioenergy and phasing out unabated fossil fuels.

The energy industry of developed countries today is developing in the direction of the so-called 3Ds, namely decarbonization, decentralization and digitalization. The development of the domestic energy industry must be coordinated with modern global trends. That is why it is necessary to determine the features of decarbonization as one of the key factors that will influence the energy sector in the coming decades.

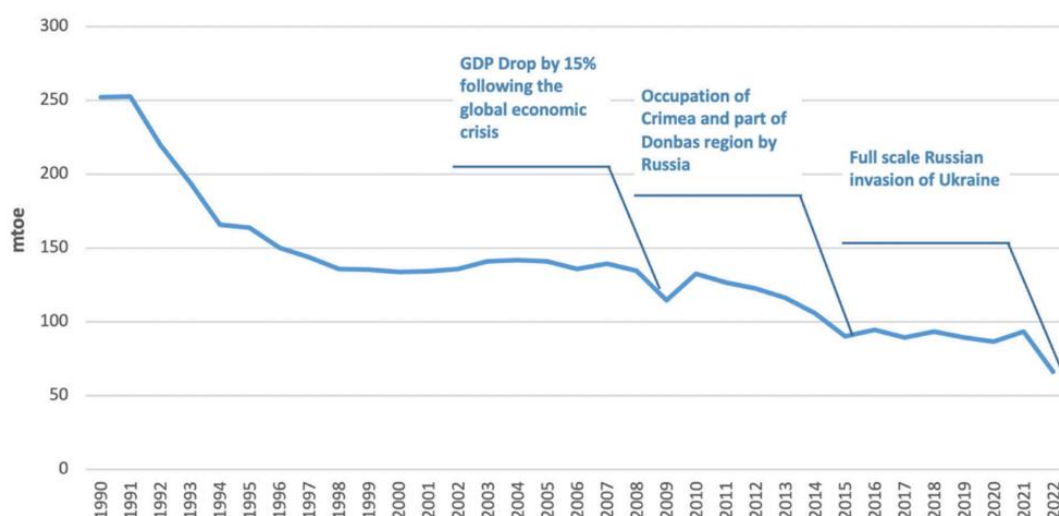


Figure 2. Total primary energy supply (mtoe), Ukraine 1990-2022

Source: formed by the authors on basis [18].

The demand for energy decarbonization in the modern world is connected with the fact that the majority of greenhouse gas emissions occur in connection with energy consumption in various sectors of the economy, in particular, the housing sector, industry, services, and transport. In order to achieve the environmental goals of stopping climate emissions, it is necessary to reduce the consumption of fossil fuels.

The UN report states that greenhouse gas emissions need to be reduced by 45% by 2030 compared to 2010 levels in order to reach the target of 1.5°C by 2050.

However, as can be seen from the Fig. 3, the total emissions of CO₂ in the world continue to grow.

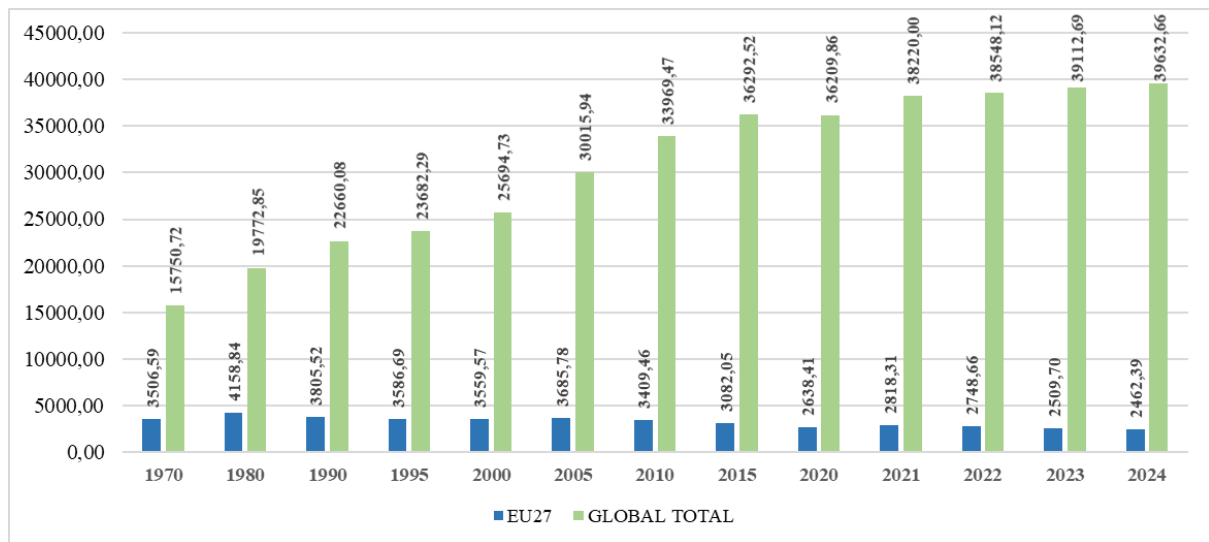


Figure 3. CO2 emissions in EU27 and in the world 1970-2024

Source: formed by the authors on basis [18].

On the other hand, in Ukraine, the indicator is decreasing, as can be seen from the Fig. 4.

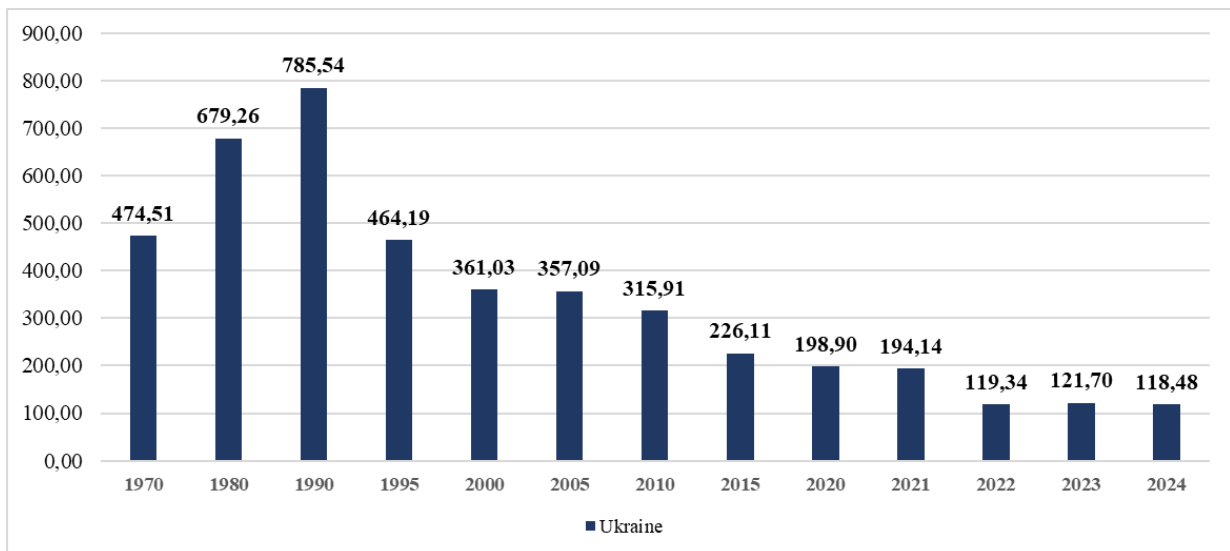


Figure 4. CO2 emissions in Ukraine 1970-2024

Source: formed by the authors on basis [18].

The ratio of emissions to GDP is quite informative, which demonstrates the prevalence of this indicator in Ukraine compared to the EU-27 and the world (Fig. 5), and therefore once again emphasizes the relevance of this issue for Ukrainian enterprises.

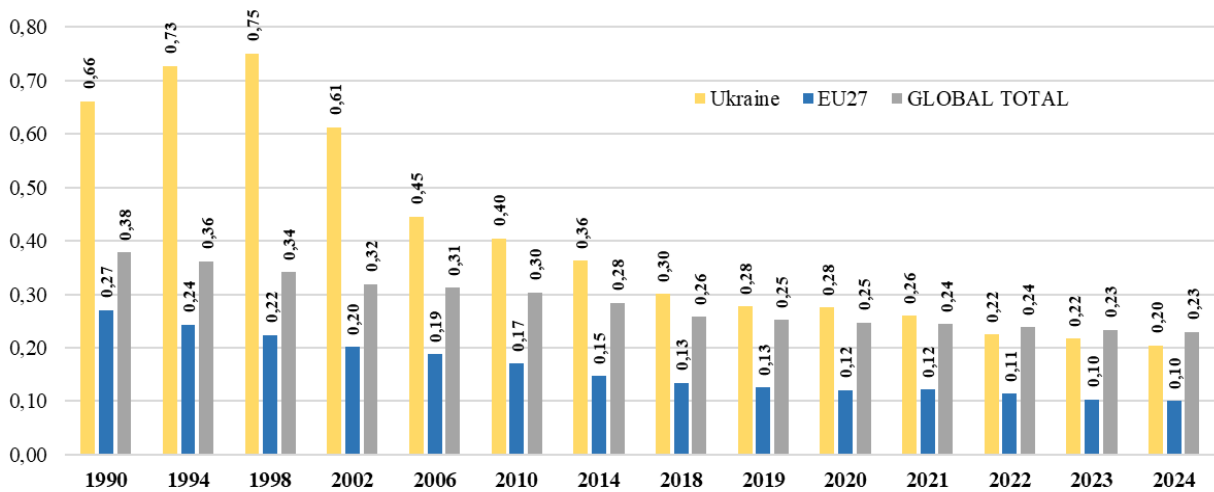


Figure 5. CO2 per GDP emissions 1990-2024

Source: formed by the authors on basis [18].

This requires the development of measures aimed at the transition to the use of renewable energy sources that are cleaner and inexhaustible.

We consider the main pillars of such structural changes to be:

- Renewable energy sources.
- Restrictions on mining.
- Rejection of coal generation.
- Capture, use and storage of carbon dioxide.
- Hydrogen energy (Fig. 6)

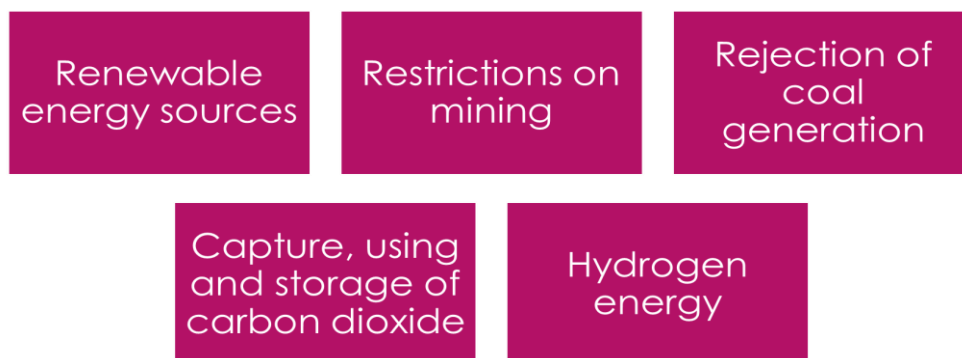


Figure 6. The main pillars of the structural changes of the green transition of the energy sector

Source: formed by the authors

So, the driving force behind the decarbonization of the economy is the transition from fossil fuels to renewable energy sources; energy-efficient consumption, as well as reducing the use of petroleum products in all sectors of the

transport industry. Most countries will achieve carbon neutrality by 2050, and the fight against climate change will lead to a transformation in global markets, in particular, the consumption of such resources as hydrogen and carbon will increase significantly. A key priority of the European Union's policy is to achieve carbon neutrality and carry out structural transformations in the economy, in particular through the introduction of new rules of international trade. Considering the global trend of decarbonization and the active policy of the EU in terms of the "green" transition, blocking the development of domestic alternative energy deprives our state of integration with European markets. This is likely to threaten Ukraine's European integration course.

That is why the driver of decarbonization in our country should be structural changes in the energy industry.

It is proposed to choose hydrogen energy, the nuclear sector and a possible combination with an automobile gas filling compressor station, which are connected to the main gas pipeline system

The enterprises also need to have an effective management system in place to ensure continual improvement of their business processes with the aim of fulfilling modern methods of business process management [9][12]. Constant management of knowledge on various links in the business process is also essential for efficient manufacturing enterprises, which can be achieved through systematic thinking, rather than traditional methods [13]. Furthermore, dynamic assessments of innovative activities of domestic enterprises are crucial for their competitiveness in the modern market, which can be achieved by analyzing the efficiency of innovative activities using modern methods [14]. However, the production of engineering products using offset printing presents a challenge as it is an obvious outsider in business processing, which is confirmed by global trends in reducing its share [15]. In conclusion, building a unified model for analyzing business processes using machine economy in relation to modern enterprises is an important step towards achieving successful green transition and worth scientific exploration in both knowledge development and process improvement [16][17].

In modern enterprises, it is crucial to have a deliberate and efficient management system to build sustainable advantages over competitors [9]. This is where business process management comes into play. Business process management involves analyzing various aspects of the contemporary enterprise, such as efficient collection, development, and processing of knowledge about the environment [10]. The aBPR concept is one approach that directs users towards business process improvement based on a sampling of researched enterprises. This method utilizes correlation and regression analysis to build a model for continuous improvement of business processes with the aim of fulfilling modern methods of business process management in Slovak [11][12]. In the management of modern manufacturing enterprises, it is essential to perform constant management on the knowledge of various links in business processes and to do so efficiently through systematic thinking. Traditional methods are no longer adequate [13]. In assessing the efficiency of innovative activity, the issue of assessment of efficiency of innovative activity of domestic enterprises arises. It is important for enterprises to analyze business processes using machine economy in relation to modern enterprises to remain competitive. The dynamism and competitiveness of modern enterprises are worth scientific exploration, both in knowledge development and process improvement [14][17]. In this context, a unified enterprise modeling approach named Enterprise is provided to promote a better understanding of business processing [16]. However, it should be noted that there are certain business processes that may be obvious outsiders to these studies, such as the business process for the production of engineering products using offset printing, which is also confirmed by global trends in reducing the share of such processes [15].

Conclusions from this study and prospects for further research in this direction. The study highlights the importance of business process efficiency in today's highly competitive and rapidly evolving business environment. The paper emphasizes the need for modern enterprises to embrace the latest technologies to improve their operations, reduce costs, and increase productivity. The use of

technology can improve coordination mechanisms and enhance business process efficiency, with coordination mechanisms playing a key role in this process. The analysis and design of work flows and processes is important for enhancing business process efficiency, including financial-economic, resource-production, external integration, and organizational criteria. Automation of repetitive tasks, streamlining of workflows, and optimization of resource allocation can all contribute to achieving greater efficiency. The paper also emphasizes the need for businesses to focus on eliminating wasteful activities and improving their supply chain management systems to enhance their overall effectiveness. Collaborative planning and forecasting are important coordination mechanisms for managing supply net-works, and effective BPM and SCC practices lead to enhanced performance and collaborative benefits. The study highlights the significance of IT governance mechanisms in improving business process performance, which can be analyzed through the resource-based perspective, economic theory of complementarities, and relatedness concept. The paper concludes by suggesting potential future re-search directions in the relevant area, emphasizing the importance of contextualizing findings in the realm of social change. Overall, the study provides valuable insights into the significance of business process efficiency and lays the ground-work for future research in the field.

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