

Electronic scientific and practical journal
**INTELLECTUALIZATION OF LOGISTICS
AND SUPPLY CHAIN MANAGEMENT**

#28 (2024)
December '24



WWW.SMART-SCM.ORG

ISSN 2708-3195

DOI.ORG/10.46783/SMART-SCM/2024-28

ISSN 2708-3195



Electronic scientific and practical publication in economic sciences

Electronic scientifically and practical journal “Intellectualization of logistics and Supply Chain Management” included in the list of scientific publications of Ukraine in the field of economic sciences (category "B"): **Order of the Ministry of Education and Culture of Ukraine dated October 10, 2022 No. 894 (Appendix 2)**

Field of science: Economic.

Specialties: 051 – Economics; 073 – Management

ISSN 2708-3195

DOI: <https://doi.org/10.46783/smart-scm/2024-28>

The electronic magazine is included in the international scientometric databases:
Index Copernicus, Google Scholar

Released 6 times a year

№ 28 (2024)

December 2024

Founder: Viold Limited Liability Company

Editor in Chief: Hryhorak M. Yu. – Doctor of Economics, Ass. Professor.

Deputy editors-in-chief: Koulyk V. A. – PhD (Economics), Professor.
Marchuk V. Ye. – Doctor of Tech. Sci., Ass. Professor.

Technical editor: Harmash O. M. – PhD (Economics), Ass. Professor.

Executive Secretary: Davidenko V. V. – PhD (Economics), Ass. Professor.

Members of the Editorial Board:

SWIEKATOWSKI Ryszard – Doctor of Economics, Professor (Poland);

POSTAN M. Ya. – Doctor of Economics, Professor;

TRUSHKINA N. V. – PhD (Economics), Corresponding Member of the Academy;

KOLOSOK V. M. – Doctor of Economics, Professor;

ILCHENKO N. B. – Doctor of Economics, Ass. Professor;

SOLOMON D. I. – Doctor of Economics, Professor (Moldova);

ALKEMA V. H. – Doctor of Economics, Professor;

Henryk DŹWIGOŁ – PhD (Economics), Professor (Poland);

SUMETS O. M. – Doctor of Economics, Ass. Professor;

STRELCOVÁ Stanislava – PhD (Economics), Ass. Professor, (Slovakia);

RISTVEJ Jozef (Mr.) PhD (Economics), Professor, (Slovakia);

ZAMIAR Zenon – Doctor of Economics, Professor, (Poland);

SMERICHEVSKA S. V. – Doctor of Economics, Professor;

GRITSENKO S. I. – Doctor of Economics, Professor;

KARPENKO O. O. – Doctor of Economics, Professor;

PATKOVSKYI S. A. – Business practitioner.

The electronic scientific and practical journal is registered in international scientometric data bases, repositories and search engines. The main characteristic of the edition is the index of scientometric data bases, which reflects the importance and effectiveness of scientific publications using indicators such as quotation index, h-index and factor impact (the number of quotations within two years after publishing).

In 2020, the International Center for Periodicals (ISSN International Center, Paris) included the Electronic Scientific and Practical Edition "Intellectualization of logistics and Supply Chain Management" in the international register of periodicals and provided it with a numerical code of international identification: ISSN 2708-3195 (Online).

Recommended for dissemination on the Internet by the Academic Council of the Department of Logistics NAU (No. 7 of February 26, 2020). Released 6 times a year. Editions references are required. The view of the editorial board does not always coincide with that of the authors.

Electronic scientifically and practical journal "Intellectualization of logistics and Supply Chain Management" included in the list of scientific publications of Ukraine in the field of economic sciences (category "B"): **Order of the Ministry of Education and Culture of Ukraine dated October 10, 2022 No. 894 (Appendix 2)**

Field of science: Economic.

Specialties: 051 – Economics; 073 – Management

t.me/smart_scm
facebook.com/Smart.SCM.org
twitter.com/ScmSmart

DOI: <https://doi.org/10.46783/smart-scm/2024-28>

e-mail: support@smart-scm.org

тел.: (063) 593-30-41

<https://smart-scm.org>

Contents

INTRODUCTION	6
MARCHENKO V.S. Postgraduate Student, National Aviation University (Ukraine), BUGAYKO D.O. Doctor of Science (Economics), Professor, Academician of the Academy of Economic Sciences of Ukraine, Corresponding Member of the Transport Academy of Ukraine, Vice - Director of ES International Cooperation and Education Institute, Instructor of ICAO Institute, Professor of the Logistics Department, National Aviation University (Ukraine), PALYVODA O.M. Doctor of Science (Economics), Professor, Professor of the Management of Foreign Economic Activities of Enterprises, National Aviation University (Ukraine)	
<i>THE PROSPECTS OF HYDROGEN AS A FUEL OF THE FUTURE: THE IMPORTANCE OF DEVELOPING HYDROGEN TECHNOLOGIES IN UKRAINE AND THE WORLD</i>	7 – 18
GRYTSENKO S. I. Doctor of Economics, Professor, Professor of Logistics Department of National Aviation University, NELIPOVYCH L. O. Master student of Logistics Department of National Aviation University (Ukraine)	
<i>THE ROLE OF EXPORT-IMPORT ACTIVITY IN THE DEVELOPMENT OF THE NATIONAL ECONOMY: LOGISTICS ASCPECT</i>	19 – 25
DAVYDENKO V.V. PhD (Economics), Associate Professor, Associate Professor of Logistics Department National Aviation University (Ukraine), SUVOROVA I.M. PhD (Economics), Associate Professor, Associate Professor of Logistics Department National Aviation University (Ukraine)	
QUALITY SUPPORT OF AN INNOVATION-ORIENTED ENTERPRISE	26 – 35
KOBETS I. K. Bachelor's student of the Institute of Aerospace Technologies, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Ukraine), KULYK S. V. Bachelor's student of the Institute of Aerospace Technologies, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Ukraine), BOIARYNOVA K. O. Doctor of Economic Sciences, Professor, Professor of the Department of Economic Cybernetics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Ukraine), ROCHSHYNA N. V. PhD in Economics, Associate Professor, Associate Professor of the Department of Economic Cybernetics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Ukraine)	
ECONOMIC ANALYSIS OF AIRLINE PRICING: RETROSPECTIVE ANALYSIS AND CURRENT STATE	36 –46



HUBARIEVA I. O. Doctor of Sciences (Economics), Professor, Research Center for Industrial Problems of Development of NAS of Ukraine (Ukraine),
HARMASH O.M. PhD (Economics), Associate Professor, Associate Professor at the Logistics Department, National Aviation University (Ukraine),
TRUSHKINA N.V., Ph.D. (in Economics), Senior Researcher Research Center for Industrial Problems of Development of the NAS of Ukraine (Ukraine),
SHKRYGUN Yu. O., Postgraduate Student, Institute of Industrial Economics of NAS of Ukraine (Ukraine), **PATLACHUK T. V.**, Postgraduate Student, Research Center for Industrial Problems of Development of the NAS of Ukraine (Ukraine)

DIGITAL TRANSFORMATION OF ENTERPRISE' LOGISTICS ACTIVITIES:
BIBLIOMETRIC AND TREND ANALYSIS

47 –70

ZAHORODNIA A.S. PhD in Management, Associate professor of the Department of international relations and political consulting, Institute of law and public relations, Open International University of Human Development "Ukraine" (Ukraine), **Dr. Manish Sharma** PhD in Business Administration, Assistant Professor of the Department of Business Administration, Jaipur School of Business, JECRC University, Jaipur, Rajasthan (India)

INTERNATIONAL EXPERIENCE IN BUSINESS PROCESS MANAGEMENT: RELATIONS BETWEEN UKRAINE AND THE REPUBLIC OF INDIA

71 –77

DABIZHA V.V. PhD in Public administration, Associate Professor, Associate Professor of the Department of International Relations and Political Consulting, Open International University of Human Development «UKRAINE» (Ukraine),
DRYHA D. Yu. Postgraduate student of the Department of International Relations and Political Consulting, Open International University of Human Development «UKRAINE» (Ukraine), **PYSKUN D.V.** Postgraduate student of the Department of International Relations and Political Consulting, Open International University of Human Development «UKRAINE» (Ukraine)

THE INFLUENCE OF THE EXTERNAL AND INTERNAL ENVIRONMENT ON THE FORMATION OF STRATEGIC MANAGEMENT OF THE ENTERPRISE

78 –86

UDC 620.97: 661.968: 339.97

DOI: <https://doi.org/10.46783/smart-scm/2024-28-1>

JEL Classification: I18, J23, M12.

Received: 18 October 2024

Marchenko V. S. Postgraduate Student, National Aviation University (Ukraine)

ORCID – 0009-0000-8959-8720

Researcher ID –

Scopus author id: –

E-Mail: vsmarch@ukr.net

Bugayko D. O. Doctor of Science (Economics), Professor, Academician of the Academy of Economic Sciences of Ukraine, Corresponding Member of the Transport Academy of Ukraine, Vice - Director of ES International Cooperation and Education Institute, Instructor of ICAO Institute, Professor of the Logistics Department, National Aviation University (Ukraine)

ORCID – 0000-0002-3240-2501

Researcher ID – ABF-5564-2021

Scopus author id: – 57216582348

E-Mail: bugaiko@nau.edu.ua

Palyvoda O.M. Doctor of Science (Economics), Professor, Professor of the Management of Foreign Economic Activities of Enterprises, National Aviation University (Ukraine)

ORCID – 0000-0001-9714-9765

Researcher ID – S-1138-2016

Scopus author id: – 36081316100

E-Mail:

THE PROSPECTS OF HYDROGEN AS A FUEL OF THE FUTURE: THE IMPORTANCE OF DEVELOPING HYDROGEN TECHNOLOGIES IN UKRAINE AND THE WORLD

Vladyslav Marchenko, Dmytro Bugayko, Olena Palyvoda. «*The prospects of hydrogen as a fuel of the future, the importance of developing hydrogen technologies in Ukraine and the world*». The article explains that environmental pollution, the depletion of natural resources and climate change are modern challenges that have a global scale. Their aggravation has led to horrible consequences that can now be seen in all countries of the world. Difficulties in the energy sphere and high dependence on traditional fossil fuels call into question environmental, economic and social safety. This stimulates humanity to look for new ideas, solutions and environmentally friendly alternatives. In our time, among such highly promising variants, hydrogen can be highlighted, which, due to its unique properties, can become the fuel of the future. In the article, the concept of hydrogen as a resource and fuel is explained, its unique characteristics and reserves are noted, its key types and ways to make them are indicated, the modern prospects of hydrogen technologies and their importance are considered. Examples of hydrogen usage in a big number of spheres were given, special attention was paid to successes in the transport and logistics in the process of managing supply chains. In this

paper, it was emphasised that hydrogen is highly promising for road, rail, air, water and even space transport, and examples of such modern initiatives were given. In a similar way, in this work, the main advantages that can be gained from the use of hydrogen were pointed out and the key contours of the development of this sphere in the coming years were described, both in our country and abroad. As a result, the reason why it is so important to continue to research and study this direction was highlighted.

Keywords: development, ecology, hydrogen, technologies, efficiency, prospects, fuel, transport, logistics, supply chain management (SCM)

Владислав Марченко, Дмитро Бугайко, Олена Паливода. «Перспективи водню, як палива майбутнього, важливість розвитку водневих технологій в Україні та світі». Стаття пояснює, що забруднення навколишнього середовища, вичерпання природних ресурсів та зміна клімату є сучасними викликами, які мають глобальний масштаб. Їх загострення призвело до жаклих наслідків, які зараз можна побачити в усіх країнах світу. Складнощі в енергетичній сфері та висока залежність від традиційних, викопних видів палива ставить під сумнів екологічну, економічну та соціальну безпеку. Це стимулює людство шукати нові ідеї, рішення та екологічно чисті альтернативи. У наш час серед таких високоперспективних варіантів можна виділити водень, який завдяки своїм унікальним властивостям може стати паливом майбутнього. У статті пояснено концепт водню як ресурсу та палива, зазначено його унікальні характеристики та запаси, вказано його ключові типи та способи їх створення, розглянуто сучасні перспективи водневих технологій та їх важливість. Було наведено приклади застосування водню в великій кількості сфер, особлива увага була приділена успіхам в транспортній та логістичній галузі в процесі управління ланцюгами постачання. В цій роботі було підкреслено, що водень є високоперспективним для дорожнього, залізничного, повітряного, водного та навіть космічного транспорту, наведено приклади таких сучасних ініціатив. Аналогічним чином, в цій роботі було вказано на головні переваги, які можна отримати від використання водню та описано ключові контури розвитку даної сфери в найближчі роки, як в нашій країні, так і за кордоном. Як результат, було підкреслено причину, чому так важливо продовжувати досліджувати та вивчати цей напрямок.

Ключові слова: розвиток, екологія, водень, технології, ефективність, перспективи, паливо, транспорт, логістика, управління ланцюгами постачання.

Introduction. In our time, humanity is facing a great number of challenges. Many of them have a global, existential scale and threaten not only people's lives but also the stability of ecosystems. They can include various environmental problems, starting with the pollution of ground, air and water, and ending with climate change, which appears in the form of extreme weather conditions and seriously affects the level of biodiversity around the world. It is impossible not to mention the current problems in the energy sector. These questions are particularly acute as the level of consumption of non-renewable natural resources such as natural gas, oil and coal is really high and even continues to grow. Scientists from around the

world are concerned with the rapid depletion of their reserves, as this poses significant threats to the safety of future generations and the environment in general.

It is very important for humanity to work now on finding new, modern and safe energy sources that will be able to replace the well-known traditional fuels. Special attention should be paid to variants that have a low impact on the environment and climate change. Intensive technological development in the sphere of alternative energy sources usage will allow decreasing our dependence on fossil fuels and protecting the environment.

One of the most modern and innovative solutions today is hydrogen. It is the resource

that many scientists consider to be the fuel of the future. Hydrogen has a truly giant undiscovered potential. Many scientists see it as the next evolutionary step in the development of the energy sector. Due to its special characteristics and properties, it has all chances to make an energy revolution. Nowadays, it is important to continue researching this question in the scientific community, to look for new, effective ways to develop it.

The purpose of the article is to explain the essence of hydrogen as a resource and fuel, to reveal its unique characteristics, types and global significance. This article will not only explain the possible ways of hydrogen usage in various industries, but also outline the key prospects for hydrogen technologies both in Ukraine and in the world.

Presentation of the main results. Today, humanity is facing many serious challenges that threaten life on the planet. The problems of environmental pollution, depletion of natural resources and climate change are among them. Currently, these

issues are so critical that turning a blind eye to them can lead to fatal consequences, not only for the modern society, but also for all future generations. Each such problem is very complex and requires a special approach and different, appropriate countermeasures.

It is impossible not to mention the significant household wastes, industrial and transport emissions. With each new year, they accumulate more and more in the ground, air and water. It is extremely important for humanity to prevent their pollution, as this negatively affects human health and the stability of entire ecosystems. An equally serious threat today is climate change. The importance of climate change, which is largely due to rising CO₂ emissions, has been recognized not only internationally but globally, by all countries committing themselves to sustainable development [1]. Its global impact and negative consequences can now be seen in all countries of the world, including Ukraine. An example of the extreme heat in Africa can be seen in Fig. 1.



Figure 1 – An example of the extreme heat in Africa

Source: https://www.un.org/sites/un2.un.org/files/unsg_call_to_action_on_extreme_heat_for_release.pdf

Large volumes of greenhouse gas emissions into the atmosphere significantly worsen the current situation. Greenhouse gases in our atmosphere act like the glass in a

greenhouse, letting light through but stopping heat from escaping [2]. Rising sea level and various extreme weather conditions, such as large-scale droughts and severe

floods, are examples of serious challenges that not only pose a big threat to product flows but also hamper agricultural activities in general.

The high dependence on non-renewable resources, such as natural gas, coal or oil, poses a significant challenge to humanity. The gradual depletion of the relevant reserves will lead to its deficit on the market in the future. This will not only have a negative impact on the availability of energy or changes in its cost, but will also painfully affect the economies of many countries, especially those that have not paid enough attention to this issue. Knowing what to expect helps us adapt and prepare for a more resilient future [3].

All of the above mentioned examples perfectly demonstrate why the goal of using other prospective resources, such as hydrogen, is so important in our time. The question of finding effective, environmentally friendly energy sources should remain a priority.

In our time, all possible questions connected with the energy sector are quite sensitive. And this is not surprising, as the level of well-being of the population directly depends on its stability, environmental friendliness and safety. Humanity was able to realise the scale of the existing problem, and therefore began to gradually focus on the active development of alternative energy sources and new technologies. Not so long ago, reaching significant success in the use of solar, wind, geothermal, hydropower or bioenergy seemed fantastic, but today it is our routine reality. Despite the fact that all the electricity generated has undoubtedly allowed humanity to reduce greenhouse gas emissions and partially reduce dependence on fossil fuels, it must be admitted that it has not yet been able to become a global panacea. This is primarily due to the slow pace

of implementation of these complex technologies, as well as the presence of a number of significant drawbacks that should not be forgotten.

The need to find new, ecological energy solutions has prompted many scientists to continue their researches and turn their attention to hydrogen as a very promising resource. Today, hydrogen is seen as a highly prospective energy solution. With each new year, it is more and more often mentioned on the daily agenda as the «fuel of the future». Hydrogen has a wide range of unique properties and characteristics that, if properly managed, could make it a key to achieving sustainable energy in the future. That is why in this paper, the nature of hydrogen will be revealed, its high importance as a fuel will be explained, and the prospects for hydrogen technologies in general will be outlined.

Hydrogen is easily the most abundant element in the universe [4]. It does not have a smell or colour. Under standard conditions, it is a gas of diatomic molecules with the H_2 formula. It is worth noting that it is lighter than air, which is valued by various specialised spheres, especially aviation and space industries. Hydrogen has a number of features that make it extremely important for the energy sector. First of all, it should be noted that it is a flammable gas. It is so popular in the modern market because of its high energy efficiency and environmental friendliness. Unlike traditional fuels, its combustion does not produce harmful emissions, but rather the formation of ordinary water vapour. This is what makes it such an attractive environmental source of energy.

The classification of hydrogen is complex and is determined by the methods of its production. Each type has been assigned its own colour in the name, which is perfectly demonstrated in Fig. 2.



Figure 2 – Types of hydrogen
 Source: Developed by Vladyslav Marchenko

This decision allowed to better associate each type with its environmental impact and energy source. The key ones today are green, blue, grey, turquoise, brown, black, yellow and pink hydrogen. There are many ways to

obtain them. They differ in terms of economic efficiency and environmental friendliness. Types of hydrogen and ways to make them are shown in Table 1.

Table 1. Types of hydrogen and ways to make them

Type	How this type of hydrogen is made
Green hydrogen	is made by electrolysis powered by renewable energy sources.
Blue hydrogen	is made by steam methane reforming, with carbon capture and storage technology.
Grey hydrogen	is made by steam methane reforming from natural gas without carbon capture.
Turquoise hydrogen	is made by methane pyrolysis, that yields solid carbon instead of CO_2 .
Brown hydrogen	is made by gasifying coal, with «brown» typically referring to lignite coal
Black hydrogen	is made by gasifying coal, with «black» typically referring to bituminous coal.
Yellow hydrogen	is made by electrolysis powered by grid electricity from some mixed sources.
Pink hydrogen	is made by electrolysis with nuclear power as an energy source.

Source: Developed by Vladyslav Marchenko & Dmytro Bugayko

The above information clearly indicates that hydrogen is a truly unique energy resource that has the potential to become a modern, environmentally friendly alternative to traditional fuels. The presence of a great number of methods for its production is also a strong plus. Of course, modern scientists concerned with minimising the negative impact of humans on the environment are particularly interested in green hydrogen. Green hydrogen is an ecologically clean

solution, as its production through electrolysis uses renewable energy. When it is used, it is possible to safely split water without CO_2 emissions, which is undoubtedly very important. With the right approach, green hydrogen can noticeably simplify the global transition to clean energy. Experts believe that its popularity and competitiveness will increase strongly in the future following the development of renewable energy sources, as this will make the cost of green hydrogen

production more attractive. Reducing the level of greenhouse gas emissions into the atmosphere through the use of hydrogen technologies can be a countermeasure to climate change. Greenhouse gases from human activities are the most significant driver of observed climate change since the mid-20th century [5].

Regarding hydrogen reserves, it should be noted that, on the one hand, it is one of the most abundant elements in the world, but on the other hand, it can still be found in its natural form quite rarely. In practice, in most cases, we can see it in compounds. The process of truly large-scale, industrial use of hydrogen is complicated with this moment, as it is primarily necessary to achieve the separation of it from compounds using modern technologies. Hydrogen can be found in fossil fuels, various biomasses or water. The last variant is especially promising, as water is a common resource on our planet. This motivates scientists to look for new effective ways to produce it.

At present, hydrogen is used in a large number of spheres and industries. Its unique characteristics make it extremely valuable for the modern market. Ordinary people do not even realise how often in their lives they deal with products that have interacted with this resource. Hydrogen is widely used in manufacturing, and it plays a special role in the energy, chemical, medical, transport and logistics and SCM sectors.

For example, in the energy sector, hydrogen can be effectively used to generate electricity, which can power different types of equipment, enterprises, villages and even entire cities. Now, in quite difficult moments, when the demand for energy significantly exceeds the available proposal, it can act as a saviour, which will at least partially compensate this difference. No less essential

role today is played by hydrogen in the petrochemical industry. It is widely used in the production of ammonia, recycling of raw materials, oil refining, metal processing and the synthesis of various chemical compounds. And in the above mentioned medicine, hydrogen is used to synthesise a wide range of pharmaceutical substances and produce different medicines.

Separate mention should be made of the successes in the transport, logistics and SCM management, as in recent years hydrogen has found truly colossal perspectives for development in these spheres. Climate challenges have stimulated a growing interest in hydrogen as an efficient resource that can replace traditional fuels in the future, the combustion of which leads to significant carbon dioxide emissions. Today, these industries have made significant progress in the implementation of hydrogen technologies. Not so long ago, hydrogen transport was something futuristic, but now it is known all over the world. Every year, more and more innovative solutions and promising projects appear on the market. In our time, hydrogen transport is already capable of efficiently transporting people and loads over long distances without releasing greenhouse gases into the atmosphere, and some models have already managed to achieve the same high efficiency as traditional modes of transport, which is undoubtedly good. This motivates companies to think about strategies for their use and gradual purchase.

Particular attention is now focused on the development and popularisation of efficient hydrogen road transport and the creation of appropriate infrastructure for it. Modern examples of such transport include the Toyota Mirai or Hyundai Nexo, which can be seen in Fig. 3.



Figure 3 – Hyundai Nexo

Source: <https://www.hyundai.com/uk/en/models/nexo.html>

In a similar way, hydrogen is highly promising for rail, air, water and even space transport. There are a huge number of relevant developments, projects and initiatives.

A modern example of a hydrogen train is the Coradia iLint, which is shown in Fig. 4.



Figure 4 – Coradia iLint

Source: <https://en.reset.org/germany-launches-worlds-first-hydrogen-powered-train-heres-why-its-big-deal-09192018/>

One of the most famous hydrogen aircraft is HY4, which is demonstrated in Fig. 5.



Figure 5 – HY4 aircraft

Source: <https://www.airliquide.com/stories/hydrogen/world-premiere-air-liquide-contributes-first-piloted-electric-flight-powered-liquid-hydrogen>

And among hydrogen water transport, such an example is the MF Hydra ferry, which can be seen in Fig. 6.



Figure 6 – MF Hydra

Source: <https://www.schottel.de/en/portfolio/references/reference-detail/hydra>

Of course, such giant opportunities could not stay unnoticed by modern business, and that is why in our time, hydrogen technologies continue to be implemented step by step in the logistics and SCM sphere. It is worth remembering that their potential in logistics is not limited only by transportation. At present, hydrogen is already used to power logistics warehouses, stationary power plants and various types of machinery. Such a modern example is the existing practice of using hydrogen in ports to power container handlers and cranes.

There are many reasons why companies from all over the world are looking for ways to

use hydrogen technologies in logistics, and some of them have already been partially mentioned in this work. First of all, it is important to mention its high environmental friendliness, as its use can significantly reduce greenhouse gas emissions into the atmosphere. Now, when climate change is a huge problem, hydrogen acts as an effective countermeasure that can seriously decrease the ecological footprint.

No less important is the factor of high energy efficiency. Hydrogen as a fuel has good perspectives. Its unique characteristics make it a very productive and convenient resource for all types of transport. As fossil fuel

reserves continue to decline rapidly at the present time, hydrogen may become a resource that will gradually replace them in the future.

The factor of using different types of fuel is also highly relevant in today's market. It is valued by companies that do not want to rely on a single energy resource and wish to reduce their dependence on fossil fuels. Being prepared to manage different energy resources allows them to avoid risks and periods of instability in the energy market.

Today, the sphere of hydrogen technologies continues its active development. The first one to master these technological innovations will be able to gain serious competitive advantages. This includes financial benefits, attraction of investments, effective marketing, sustainable development, etc. All of the above listed examples are just the beginning of a gigantic list of reasons and that is why the involvement of hydrogen technologies in the logistics and SCM sector should become one of the top priorities for its development.

In order to fully disclose the chosen topic, it is important to describe the key contours of this area's development in the coming years. At present, they are quite promising, both in our country and abroad. Speaking about Ukraine, it is worth noting that we have a very good potential for its production. Experts are tending to the opinion that our country can get a key role in the European hydrogen

market. This can be clearly seen in the interaction between the European Union and our government. Western countries are ready to invest large amount of money in the development of hydrogen technologies and corresponding infrastructure in our country. In the context of the global transition to non-carbon technologies, this partnership is considered by them to be very mutually beneficial and promising.

Ukraine continues to work on approving an effective hydrogen strategy. In it, the active use of our resources for hydrogen production will be specified. Of course, the European Union is most interested in green hydrogen, and that is why active discussions are ongoing on the development of renewable energy in Ukraine. This primarily concerns the installation of solar panels and the construction of powerful wind farms. There are real plans to create Hydrogen Valleys in Zakarpattia and Odesa regions. A significant advantage of our country is its well-developed gas transmission system, which can be adapted to transport hydrogen and used for its further export.

In 2023, Ukraine signed an agreement to join the European Union's Single Market Programme. Memorandum of understanding between the European Union and Ukraine on a Strategic Partnership on Biomethane, Hydrogen and other Synthetic Gases was also signed at this meeting, what can be seen in Fig. 7.



Figure 7 – Memorandum of understanding between the European Union and Ukraine on a Strategic Partnership on Biomethane, Hydrogen and other Synthetic Gases

Source: https://x.com/Denys_Shmyhal/status/1621193538271678470/photo/1

It is extremely important for Ukraine not to miss the chance to realise its potential in this area. Experts forecast that this direction of development will not only allow us to strengthen our economy and improve our ties with the European Union, but also significantly reduce our carbon footprint and improve the ecology, which is a crucial goal in our time.

The transition to a zero-carbon economy is a global, truly complex task, and hydrogen plays an important role in it. A great number of countries have already achieved some success in this sphere and are forming promising plans for the future. In the case of the above-mentioned European Union, it has developed a well-thought-out development programme called «The European Green Deal», aimed for many years ahead. It includes not only significant investments in green hydrogen production projects, but also sets ambitious goals for the development of hydrogen infrastructure. Germany plays a particularly active role in this area and is

intensively working on the development of a strong hydrogen economy.

The United States also sees the serious potential of hydrogen. They not only make big investments in researching its possible capabilities, but also spend a lot of money on the development of hydrogen technologies.

This sector has not been unnoticed by Japan either. It has created a long-term plan to implement its own hydrogen strategy, which calls for expanding the role of hydrogen in the transport, logistics and energy sectors. Japan plans to significantly reduce greenhouse gas emissions through the development of hydrogen transport and refuelling stations.

As a global player, China also could not pass by such a promising direction. At present, it is seriously funding the development of hydrogen technologies and aims to become a global leader in hydrogen production. It is highly interested in the use of hydrogen in various fields, especially in manufacturing and transport.

All of these plans once again clearly demonstrate the interest of the global community in hydrogen as the «fuel of the future» and a resource that can be used in a huge number of industries. However, on the other hand, it has to be admitted that its current development remains limited by a number of obstacles. These include a lack of investments, poorly developed infrastructure, weak political will on the part of many leaders, and the initial high cost of the implementation. All of them can be and should be resolved in order to achieve the set objectives.

The potential of hydrogen technologies remains incredibly high. It is important to continue research and development in this area. To reach real success in this direction, it is necessary to reduce production costs and improve fuel technologies. The goals set are very ambitious and complex, and therefore it is crucial to establish international cooperation and collaboration. This will accelerate progress, create unified hydrogen standards, ensure the exchange of precious experience and new technological solutions. The article is a continuation of a series of publications by the authors on aspects of the development of "green" logistics and supply chain management [6-7].

Conclusions. The result of this article was the achievement of all earlier defined objectives. In this work, it has been clearly indicated that problems such as environmental pollution, depletion of natural resources and climate change are global challenges today. Their gradual aggravation has led to horrific consequences that can now be seen in all countries of the world. This has pushed humanity to look for new ideas, solutions and countermeasures that could improve the existing situation. Difficulties in the energy sector and high dependence on natural gas, coal or oil pose a serious threat to humanity. Their active and large-scale extraction is harmful to the environment, when their combustion is accompanied by significant greenhouse gas emissions into the atmosphere, which contributes to climate

change. That is why, in recent years, scientists have turned their attention to the use of hydrogen as a solution that can be an effective countermeasure to these challenges. Hydrogen, due to its unique characteristics, high energy efficiency and environmental friendliness, has the potential to become a key element in the transition to a no-carbon economy. The question of finding effective, ecologically safe energy sources should remain a priority, and that is why in this article it was explained in detail what hydrogen is, both in terms of a resource and a fuel, highlighted its reserves, importance, unique properties and characteristics, key types of hydrogen and ways to make them. We saw that hydrogen, as a resource and energy source, has a huge potential, especially for overcoming the above challenges. In this article, it was emphasised that in our time, hydrogen is used in a large number of spheres and industries. It is important not only for manufacturing, but also has a special role in the energy, chemical, medical, transport and logistics sectors. In this paper, detailed examples of successes in these areas were provided, and significant achievements in the transport, logistics and SCM sector were emphasised separately. In this work, it was explained that hydrogen is highly prospective for all types of transport, pointed out the key advantages that can be gained from its use and described the key contours of the development of this sphere in the coming years, both in our country and abroad. These development perspectives are very serious and optimistic. Today, our country has all the opportunities to become one of the main players in the hydrogen market. Ukraine has a giant potential for hydrogen production, transportation and export, which makes it attractive for international cooperation, especially with the European Union. The development of this sphere in Ukraine can result in the creation of a great number of new job places, technological progress and improvement of the ecological situation. Nowadays, our country can get significant investments, so it

is critically important for us not to miss our chance to take advantage of the demand for hydrogen technologies. In the article, specific examples were provided to show that European countries, the United States of America, Japan, and China see serious potential in hydrogen. All of them plan to continue to explore the perspectives of hydrogen technologies and actively develop appropriate infrastructure. The interest in hydrogen remains high at the global level. Thus, hydrogen is not just a «fuel of the

future», but a truly strategically important resource that can change our future, not only in Ukraine but also around the world. Summing up all the information above, hydrogen has an enormous importance in our time. The development of this direction will help not only reduce greenhouse gas emissions but also open up a great number of new opportunities. That is why it is so important to continue to research, analyse and study this sphere.

References

1. Ovdiienko, O., Hryhorak, M., Marchuk, V., & Bugayko, D. (2021). An assessment of the aviation industry's impact on air pollution from its emissions: worldwide and the Ukraine. *Environmental & Socio-economic Studies*, 9(2), 1-10.
2. NSW Government. Causes of climate change. [Electronic resource]. – URL: <https://www.climatechange.environment.nsw.gov.au/why-adapt/causes-climate-change>
3. IPCC. Climate change in data. [Electronic resource]. – URL: <https://www.ipcc.ch/report/ar6/wg1/resources/climate-change-in-data/>
4. The Royal Society of Chemistry. Periodic Table [Electronic resource]. – URL: <https://www.rsc.org/periodic-table/element/1/hydrogen>
5. U.S. Environmental Protection Agency. Climate Change Indicators: Greenhouse Gases [Electronic resource]. – URL: <https://www.epa.gov/climate-indicators/greenhouse-gases>
6. Marchenko V.S., Bugayko D.O. (2024). "Possible ways of the sustainable development concept realisation by logistics companies, the necessity of using «green» technologies for decarbonisation of their business activity". *Intellectualization of logistics and Supply Chain Management*. [Online], vol.23, pp.17-36.
7. Marchenko V.S., Bugayko D.O. (2024). "Increasing the level of environmental friendliness of companies through decarbonisation". *Intellectualization of logistics and Supply Chain Management*. [Online], vol.24, pp.24-32.