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ECO-FORESIGHT RESEARCH IN SHAPING COUNTRY'S SCIENCE DEVELOPMENT STRATEGY REGARDING THE GREEN ECONOMY

Abstract

This article focuses on the importance of eco- foresight research in shaping the country's science development strategy in the field of green economy. The transition to a green economy requires balancing economic growth with environmental conservation, and finding a balanced model is a complex task that many specialists are actively working on. Ecoforesight, which involves the use of foresight methodology in the environmental field, plays a crucial role in identifying potential opportunities and risks for the natural environment associated with landmark innovations and global economic trends. The study aims to assess the long-term environmental impacts of current industrial activities and strategic planning of national industrial policies regarding green technologies. Scenario modeling, especially in the field of green technologies, is an important aspect of environmental forecasting due to its long-time horizons and numerous uncertainties. The article emphasizes the importance of eco- foresight research in ensuring sustainable development and innovation in the context of global strategic trends.

Key words: foresight, green economy, Delphi method, modelling, science development, ecoforesight, environmental planning.

Introduction

The transition to a green economy is a complex strategic task that requires a combination of two previously incompatible development vectors: maintaining dynamic economic growth and preserving the natural environment on a long-term basis. No country has yet managed to master this level of complexity, however, an active search for a new balanced model continues with the development of appropriate strategies.

The term "environmental foresight" (eco-foresight, English environmental) foresight or environmental futures projects), as a rule, implies the use of general foresight methodology in the environmental sector [1, 2]. That is, ecoforesight is not a unique and highly specialized type of activity (by analogy with the development and production of environmentally friendly or "green" technologies), but refers to a general scientific analytical toolkit aimed at early identification of potential opportunities and risks for the natural environment associated with basic epochal innovations and global trends in economic development.

The purpose of this study is to determine the relevance of foresight in assessing the long-term environmental consequences of current industrial activities, as well as in the strategic planning of national industrial policies regarding Green Technologies. At the same time, further industrialization is recognized as a "driver of development" and is included in the list of strategic goals of economically developed and innovative economies of the world. Accordingly, in the context of global strategic trends – innovation, neo-industrialization and sustainable development – eco-foresight of industry and the market for technical and technological innovations is a relevant area of scientific research.

Materials and methods

The article used general scientific methods of theoretical generalization, synthesis and analysis. In order to conduct a comprehensive review of the topic, the article employed a range of materials and methods. The primary methods used in this review were theoretical generalization, synthesis, and analysis. These methods allowed the researchers to critically examine and evaluate the existing literature on the topic, and draw meaningful conclusions. To gather relevant information, the researchers extensively studied various literary sources, scientific articles, and reports. These sources were carefully selected to ensure that they provided reliable and up-to-date information related to the study's topic. The researchers aimed to include a wide range of sources to obtain a comprehensive understanding of the subject matter.

The literature review process involved a systematic examination of the selected materials. The researchers thoroughly analyzed the content of each source, identifying key concepts, theories, and findings that were relevant to the study. They then synthesized the information from these sources, organizing and integrating the data to identify patterns, trends, and gaps in the existing knowledge.

Main provisions

One of the most large-scale and priority areas of environmental foresight is scenario modeling "Green Technology", which is objectively due to large time horizons and numerous uncertainties associated with the global phenomenon [3, 4].

A number of countries are implementing programs to develop a green economy and minimize the economic and social impact on nature. In the United States, the value of protected areas is considered in economic, environmental and cultural dimensions [5]. The US National Wildlife Federation [6] has achieved the adoption of legal standards supporting the "North American model of wildlife conservation" [7]. The Federal Assistance for Wildlife Restoration Act [8], which came into effect in 1937, allowed for the restoration of dozens of animal species. In recent decades, network cooperation in the field of nature conservation has intensified with the participation of numerous players. Relevant law (Wildlife Act of 1964 established principles that are still used in public land conservation in the United States. Since 2009, the US Department of Agriculture of Agriculture (USDA) has awarded

more than 200 conservation innovation grants to find new solutions for conserving protected areas in a rapidly growing economy. In Canada, environmental activities are carried out discretely, in connection with periods of increased environmental sentiment in society [9]. As a mechanism for protecting protected areas in the Canadian Arctic, registration of land ownership rights is provided [9]. The United Arab Emirates, in turn, leads among the Gulf countries in the use of clean technologies and alternative energy sources [10]. Africa's long-term Great Green Wall program is seen as a tool for greening deserts by planting a wide, continuous strip of trees from Senegal to Djibouti. An integrated approach to large-scale land restoration with the active involvement of local communities between 2015 and 2017 allowed the greening of approximately 12 thousand hectares of degraded land. It is expected that the implementation of the project will significantly expand landscape diversity and improve the quality of life [11].

Literature review

In best international Foresight practice, two modes are used using fourth and fifth generation approaches and taking into account the listed principles. This increases the relevance of such research and enhances its influence on decision-making, for example, in the development and implementation of public policy.

Mode I aims to improve or optimize an existing system [12, 13], and Mode II focuses on discussing opportunities and stimulating fundamental changes in existing paradigms [14].

The methodology of foresight research is formed based on the selected goals, objectives of the project and a specific area of its application. Any Foresight program requires decisions about what combination of methods to use and what existing sources of information to use.

The main methods of ecoforeside research are:

- Delphi method ;
- SWOT analysis;
- horizon scanning;
- scenario analysis.

In order to create evaluations of potential futures, the Delphi method gathers and organizes the opinions of a group of specialists over the course of many analysis rounds. This approach has been applied in many different ways in numerous studies conducted worldwide in a variety of sectors and for a wide range of objectives [15]. Typically, a panel of experts anonymously and independently responds to questions on potential future changes in the first round of a Delphi research, without being aware of the responses provided by other panel members [16]. In the following rounds, all of the group's results – including their own – are shown to each member. Reviewing their results and revising their conclusions in light of other participants' findings and arguments is recommended for experts. They should also pay close attention to the reasoning behind responses that fall on opposing extremes of the distribution. A Delphi analysis typically involves two to five rounds, during which either a general consensus or a range of conflicting opinions about future developments may emerge. However, consensus is not the preferred outcome [17], and an attempt to impose it may lead to the invalidation of the results [18]. On the contrary, a more objective state is considered to be the stability of experts' answers, which do not change after extensive discussion, even if they do not agree with each other. Exploring opposing views and unique minority opinions can be essential to understanding "unidentified unknowns." The ideas created (the desirability of some future state or a way of obtaining or avoiding a future state) and the justifications for the unusual perspectives of participants are significant contributions of Delphi research, in addition to the detection of ambiguity and divergence [19].

The SWOT analysis is a strategic planning tool that entails classifying the organization's external and internal environment's components into four groups:

- Attributes,
- Deficits,
- Threats,
- Opportunities.

The term “horizon scanning” describes a wide range of procedures used to recognize and comprehend significant trends that are developing in an organization’s (government agency, corporate, or non-governmental organization) or an area of interest’s (biodiversity, climate change, or ecosystem services) external environment [20]. It therefore functions as an early warning system about potential threats or opportunities, can be exploratory (generating hypotheses and searching for “unidentified unknowns”) or problem-oriented (focusing on previously identified problems), and forms the basis of other stages of foresight that are intended for further analysis of markers that have been discovered [21]. Six steps make up the technique algorithm: problem analysis, information gathering, signal identification, trend monitoring, future understanding, and response agreement [22]. The marketing professor F. Kotler [20] created the popular horizon scanning trend categorization method, which is divided into six major groups denoted by the acronym DEGEST: demography, economics, government, environment, society/culture, and technology. Global digitalization has greatly increased the method’s capabilities by giving users access to a variety of sources (online libraries, statistical databases, websites of national and international organizations), promoting expert collaboration, and offering the potential for network monitoring that is ongoing.

A more comprehensive technique for outlining several potential futures is scenario analysis, often known as scenario planning [18]. The fact that this approach is unrestricted by previous historical results makes it particularly useful for forecasting black swan events (swan-type). Rather, the approach depends on imaginative thought to provide a picture of potential futures. Tools for scenario analysis emphasize mental expansion, creativity, and heuristics to take into consideration low-probability threats and go beyond the blind spot of perceiving “unidentified unknowns” [20].

Apart from the foresight methods mentioned above, there exist over thirty other types of methods for analyzing and comprehending fundamental uncertainties related to the development of complex adaptive systems in the future. These methods include relevance trees, futures wheel, cross-effects analysis, and technological sequence analysis. New techniques are always being developed, such as layered analysis of causes and effects and techniques for using online social networks.

Results and discussion

Foresight is a collaborative effort that brings together many different stakeholders and takes into account their views, expectations and experiences. Obviously, careful preparation is the key to its success. Foresight stages include:

- precise definition of research objectives;
- involvement of various stakeholders in the process of formulating research objectives;
- determination of areas of responsibility and authority of performers;
- orientation towards practical application of research results;
- development of a plan for the implementation of research results at its early stages;
- prompt dissemination of information about the progress of the study and its objectives, as well as stimulation of the implementation of the recommendations received.

At the preparatory stage, most Foresight studies are based on the experience of other countries. Almost two thirds of countries consider such a preparatory study to be an important undertaking. It includes a detailed discussion of the potential effects and intended uses of Foresight findings and a pro-contra-analysis. All this serves as a serious success factor affecting the effectiveness of the study, as confirmed by the strong positive correlation between analytical exercises and Foresight performance.

Increasingly, Foresight is used not only as a tool for building a long-term vision, but also to identify areas of innovation in the future. This purpose statement helps structure the research process and is associated with a participatory approach that prevents the influence of unilateral interests and ensures support from the private and public sectors.

The most established traditions of conducting Foresight compared to most other countries have developed in Japan and the UK, where special structures have been created: Scientific and Technological Foresight Center in Japan, which is a division of the National Institute for Science and Technology Policy (Science and Technology Foresight Center, NISTEP), and the Foresight program

of the UK Department of Innovation, Universities and Skills (Department for Innovation, Universities and Skills).

According to the literature searches on forecasting and management, the application of the results of foresight research in the formation of a strategy for the development of science in OECD countries in the period 2020 and 2021 serves as an illustration of various features of the successful institutionalization of foresight (table 1) [21].

Table 1 – Foresight research and strengthening governance in OECD countries

Australia	Australia's capacity for foresight is housed in specialized teams across many government ministries, such as the Department of Industry, Science, Energy and Resources, the Department of Foreign Affairs and Trade, and the Department of Education, Skills, and Employment. The Center for the Future, a national resource supporting policy work, planning, and thinking through the study of strategic futures relevant to the future of national security, is funded by a joint venture between the Australian government and the Australian National University. The Australian Strategic Futures Network, a cooperative network of state and federal government foresight teams, is headed by the Futures Center. Australia's national science agency, the Commonwealth Scientific and Industrial Research Organization (CSIRO), has a dedicated Foresight Group (CSIRO Futures) and Analytics Group that employ modeling techniques to inform future strategy and policy solutions, with a focus on digital technologies and data-driven science. The group also analyzes emerging trends, drivers, and scenarios. Government agencies in Australia and New Zealand work together via the Australian Joint Agencies Scanning Network (AJASN), a shared skyline scanning service and database. Since 2004, AJASN has been in operation.
Canada	Canada boasts one of the world's most advanced government forecasting ecosystems. Based at the federal government's primary foresight agency Policy Horizons Canada (Policy Horizons), it offers cutting edge futures research, strategic foresight services, and foresight capacity building. It was established in 2009. A strong degree of support from civil service leadership is ensured by the institutional architecture that underpins Policy Horizons. The most senior nonpartisan public officers in Canada, deputy ministers, comprise the steering group to which Policy Horizons reports. This steering group directs Policy Horizons, gives it guidance, and facilitates strategic conversations around its leadership in foresight. Policy Horizons is currently among the world's largest public sector forecasting groups, employing more than 40 full-time staff members. Along with serving as a vital advocacy tool to direct cooperative forecasting efforts and develop forecasting capacity across federal government departments and agencies, this capacity enables the development of strong expertise and in-depth forecasting analysis on futures issues related to a wide range of public policy topics authority. Through Policy Horizons, a network of foresight practitioners from all throughout the Canadian government is brought together, with over 200 individuals from over 50 federal ministries and organizations. The deployment of forecasting skills across the Canadian public service depends heavily on this network. Policy Horizons organized the inaugural Futures Week conference in 2021 to introduce the concept of foresight to a larger group of government leaders.

Finland	One of the world's most advanced forecasting systems is found in Finland. After the early 1990s economic crisis and in response to security concerns stemming from Finland's geographic location, the government began to place greater emphasis on foresight. Finland is home to networks of vision in the public and commercial sectors, academia, civic society, and national and local government, which collectively create a sophisticated proactive ecology. The Finnish foresight ecosystem blends bottom-up and top-down techniques with a high degree of inclusivity because so many different sectors of society are involved. The Center is essentially including an evaluation component that contrasts actual progress with scenarios into its work by post-evaluating earlier forecasting work over time. This is perhaps the most notable development. The Parliamentary Futures Committee has been debating forecasting-related problems and the Government's Futures Report since 1993 (School for International Futures, 2021; Shallow A. et al (2020). The Finnish innovation fund Sitra and the Prime Minister's Office work together to manage the Finnish National Forecasting Network. Sitra is legally accountable to the parliament, yet it maintains a great deal of independence, including when it comes to financial management. Sitra's mission is to "ensure the future well-being of Finland" and to "support and challenge" the ruling party, frequently bringing up topics that are not necessarily of the utmost importance to people in positions of authority. International Future School (2021), 49. Section 6, paragraph 5 of the Estonian Forecasting Act, https://www.riigiteataja.ee/en/eli/ 509022018003/ consolide; interview with an Estonian foresight specialist, April 24, 2020 (date of last update: February 15, 2022). Different government ministries are equipped with their own forecasting systems. This includes ongoing future studies that have been conducted since 2003 and initiatives to develop specialized forecasting skills within each ministry. Though diverse sectoral goals can cause problems amongst ministries when forming their future visions, discussing the future together enables participants to identify and clarify these tensions. August 11, 2020, interview with a Finnish specialist in predicting; also see School for International Futures (2021). Finland's premier forecasting document is the government's Futures Report, released at the beginning of each new administration's term every four years. This practice dates back to the 1990s, when the prime minister, working with an interministerial panel, selected the study topic. All pertinent parties participate in a two-year participative procedure during which time staff and a certain budget are assigned. The report is meant to be a resource for all political parties in creating their campaign platforms, and Parliament is involved in its preparation, with an emphasis on long-term strategic concerns.
Estonian	Finland served as the model for the foresight system in Estonia. The institutionalization of foresight in Estonia is based on the Foresight Act. This bill created the Forecasting Center, a think tank inside the Estonian Parliament, and the Forecasting Council, a group of specialists in business, technology, and research. The Foresight Center's operations are approved by the Council. The center imagines potential future states in which decision-makers could "future-proof" politics. The public's input and participation are also required under the Estonian Foresight Law. The Center is essentially including an evaluation component that contrasts actual progress with scenarios into its work by post-evaluating earlier forecasting work over time. This is perhaps the most notable development. Forecasters may show senior decision makers how valuable they are using this tool.
Germany	There isn't a single central forecasting organization in Germany; instead, there is a network of public, "independent but publicly supported and publicly funded institutions." These institutions include the Federal Diplomatic Service, the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, the Federal Chancellery (Bundeskanzleramt), and the Ministry of Economic Cooperation and Development. The civilian arm of the Federal Armed Forces, the Planning Office of the Federal Armed Forces (Planungsamt der Bundeswehr), has a well-established forecasting capacity to handle more general social and technological concerns. The states of Bavaria, Baden-Württemberg, and Rhineland-Palatinate are among the subnational levels where sponsored forecasting programs or procedures are a part of the decentralized system. Forecasting efforts are organized by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung) in collaboration with subnational partners (Länder), appropriate Federal Government entities, and the German Bundestag.

European Parliament	The European Strategy and Policy Analysis System (ESPAS) network is relevant to the work of numerous units within the European Parliament that address foresight concerns. The European Parliamentary Research Service's Strategic Foresight and Opportunities Unit is one such unit that focuses on wider concerns and global trends. Along with the Strategy and Innovation Unit and the Level Liaison Unit, the Strategic Foresight and Capabilities Unit functions within the European Parliament's Research Service. Preparing reference materials for European Parliament members on current global economic challenges, social trends, and their implications for the European Union is one of its responsibilities. Seminars and briefings are two further initiatives to foster a "culture of proactiveness in the European Parliament." The Group on the Future of Science and Technology (STOA), another foresight group of the European Parliament, focuses mostly on scientific and technical topics. Informing lawmakers and taking part in legislative discussions are the goals of STOA. The eleven Standing Committees of the European Parliament have nominated 27 members to the STOA Group. Demands and requests for the completion of foresight work can be made by members of the European Parliament and its committees. The commission's makeup and the interactions between lawmakers and specialists guarantee the applicability of the foresight work. The goal of STOA is to serve as a "honest broker" and offer guidance and a forward-looking viewpoint on different possibilities while considering the possible effects that a certain decision may have on society.
Note: Compiled by the sourse [21].	

Japan is actively integrating forecasting research into its policy-making processes to achieve sustainable development. Foresight research involves identifying and analyzing emerging trends, issues and opportunities to inform long-term planning and decision making. Several institutions in Japan, including the government, research institutes and universities, actively conduct foresight research.

In Japan, science and technology innovation policies have been promoted through the Science and Technology Basic Plans, which have been formulated every five years since 1996.

Given the increased complexity of the relationship between technology and society, the study is conducted from the dual perspectives of science, technology and society. First, they studied scientific, technological and social trends through review of reference materials, etc. [horizon scanning]. They then conducted separate studies on "future society [visions]" and "future science and technology [scientific and technological perspectives]. In order to produce "images of a future society that emerged as a result of the development of science and technology [scenario]," they blended the results. Two methods are used to analyze the "future of science and technology": interdisciplinary conversation and field-specific discussion. The goal year was chosen at 2040, or about 20 years from now, while the look-ahead term was established at around 30 years from 2050. This time frame presupposes the creation of the "Society 5.0" initiative, a super-smart society.

The purpose of the study is to provide background information to support the formulation of science, technology and innovation policies/strategies, including the 6th Science Conference Technology and Innovation Baseline. Taking social conditions as a given, they explored the possibilities of new science and technology and painted a future image of the desired society based on the development of science and technology. Fifty images of a future desired society and four values were extracted from the "future society" study. In future research _ Sciences and technology [22, 23].

The opinions of 5,352 experts were received regarding the priority and prospects for achieving 702 scientific and technical topics. Additionally, automatic clustering of 702 science and technology topics was discussed, and eight areas with high interdisciplinary potential and eight domain-specific areas were identified. In the final study of the images of future society that emerged from the development of science and technology, the future of society and the future of science and technology were combined to create a conceptual scenario.

In the study, they explored the desired future of a society based on science and technology and development (figure 1, p. 16).

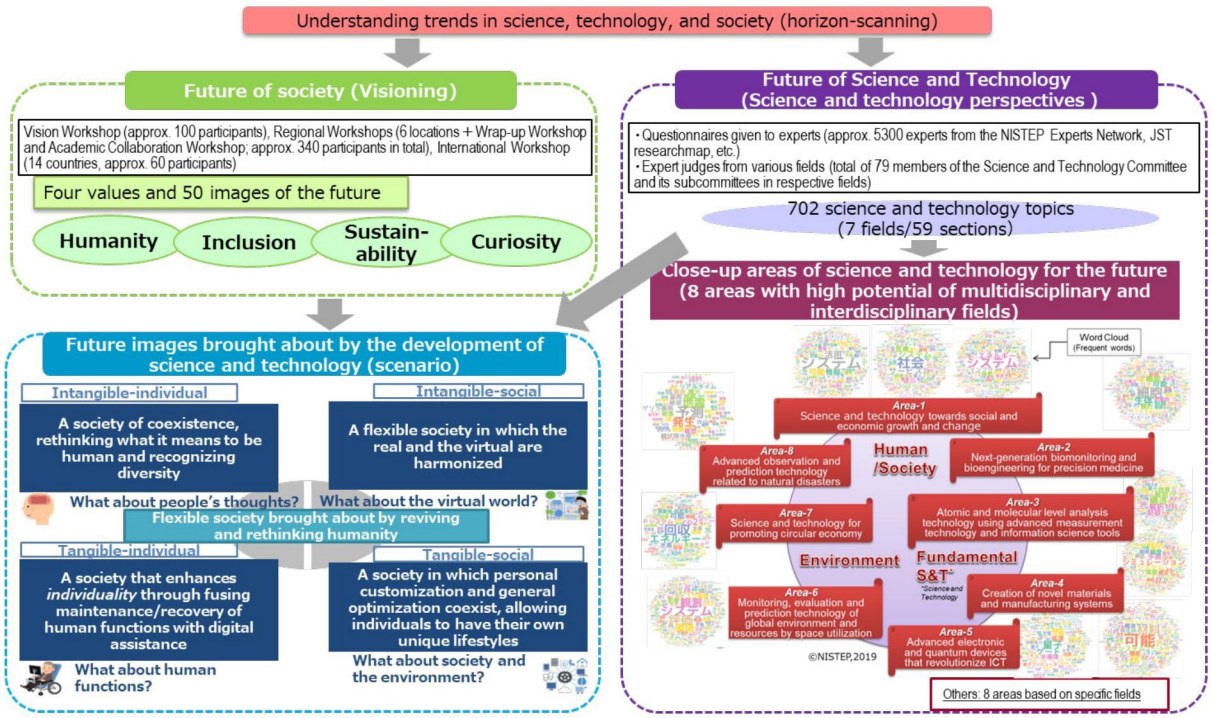

Figure 1 – The future of a society based on science, technology and development

Note: Taken from the 11th Science and Technology Foresight Scenario Planning from the Viewpoint of Globalization Summary Report – NISTEP REPORT No.183 [23].

One of the main areas of sustainable development in Japan is environmental protection. The country has set ambitious goals to combat climate change, reduce greenhouse gas emissions and develop renewable energy sources. Japan has also invested in technological advances to improve energy efficiency and reduce pollution.

Renewable Energy: Japan is investing in renewable energy sources such as solar, wind, biomass and hydropower. As of 2019, renewable energy accounted for about 18% of the country's total electricity production.

Energy efficiency: Japan places special emphasis on energy saving initiatives, especially in residential and commercial buildings. The government has introduced energy conservation standards and promoted the use of energy-efficient appliances and technologies.

Waste Management: Japan has a well-developed waste management system. Recycling rates are high, with around 80% of waste being recycled or incinerated to produce energy.

Sustainable transportation: Japan is promoting the use of electric vehicles (EVs) and hybrid vehicles to reduce greenhouse gas emissions. The number of charging stations for electric vehicles has been steadily increasing, and the government has set targets to increase the adoption of electric vehicles.

Forest conservation: Japan actively manages and protects its forests, which cover about 67% of the country's land area. Forest conservation efforts include reforestation, sustainable timber harvesting, and biodiversity conservation.

Research and Development: Japan invests heavily in research and development (R&D) related to sustainable technologies and solutions. The public and private sectors are collaborating to advance innovation in areas such as renewable energy, energy storage and smart grids. These are just a few examples of initiatives and statistics related to sustainable development in Japan. Through forward-looking research, Japan strives to identify upcoming challenges and opportunities, develop effective policies, and ensure a sustainable future for the country [23].

According to research results, ecoforesight has the following advantages:

- Demonstration of Materials: these materials provide a comprehensive overview of eco-foresight research and its applications in the formation of a science development strategy regarding the green economy;
- Eco-Foresight Research: eco-foresight is a systematic and participatory process that identifies and analyzes emerging environmental issues and trends, and explores their potential implications for the future. It involves a wide range of stakeholders, including scientists, policymakers, businesses, and civil society organizations;
- Science Development Strategy: a science development strategy provides a roadmap for the development of scientific research and innovation in a country. It identifies priority areas for research, allocates resources, and sets targets for scientific progress;
- Green Economy: a green economy is an economic system that aims to reduce environmental risks and ecological scarcities while simultaneously promoting economic growth and social equity;
- Integration of Eco-Foresight and Science Development Strategy: eco-foresight research can play a vital role in informing the development of a science development strategy regarding the green economy. By identifying emerging environmental issues and trends, eco-foresight can help policymakers and scientists prioritize research areas that are critical for transitioning to a green economy.

For example, an eco-foresight study might identify the growing threat of climate change as a major environmental issue. This information could lead to the development of a science development strategy that focuses on funding research on climate change adaptation and mitigation technologies.

Benefits of Eco-Foresight for Science Development Strategy:

- Provides a long-term perspective on environmental issues and trends
- Identifies emerging research priorities
- Informs decision-making on resource allocation
- Promotes collaboration and stakeholder engagement
- Contributes to the development of a sustainable and resilient society.

The behavior of the National Foresight in Kazakhstan is to solve such problems as substantiating the scientific, technical and innovation strategy, mobilizing resources for the development of priority areas and increasing strategic competitiveness. The foresight process in Kazakhstan was divided into three main stages: policy planning, scientific and technological planning and development of R&D programs.

In Kazakhstan, since 2010, two national scientific and technological foresights have been carried out in order to determine the priorities of scientific, technical and innovative development. First conducted in 2011–2012, the National Scientific and Technological Foresight covered a period until 2020 and was initiated by the Ministry of Investment and Development of the Republic of Kazakhstan (formerly known as the Ministry of Industry and New Technologies). In partnership with the Korea Institute of Science and Technology Evaluation and Planning (KISTEP), the foresight technique was created. A list of strategically important technologies for Kazakhstan was created using the insights from this foresight (consisting of 75 important technologies within the framework of 8 priority sectors). The Kazakhstani government designated priority sectors for innovation grant giving based on the findings of the First National Foresight. State innovation funds were awarded in 2013–2014 based on a list of strategic technologies and priority sectors identified by this foresight. It was suggested that focused technology programs be created in order to encourage the creation of strategic technologies. These programs would serve to galvanize the efforts of all involved parties and raise the bar for collaboration between research and business. Based on the application of the "triple helix" paradigm, these projects were designed in a manner radically different from previously existing patterns of interaction between government, industry, and science. Taking the lead, the Ministry of Education and Science of the Republic of Kazakhstan organized the Second National Scientific and Technological foresight in 2013, titled "System analysis and forecasting in the field of science and technology". The study's time frame was set up to run until 2030. Finding promising fields in science and technology as well as compiling a list of R&D subjects that have the potential to propel Kazakhstan's economy forward and serve as the cornerstone of its science and technology strategy were the primary objectives. Based on an evaluation of the socioeconomic impact of developing potential technologies as well as an assessment

of the technological capabilities and available resources, Kazakhstan identified priority areas for scientific and technological development. Educating decision-makers about potential directions for Kazakhstan's scientific and technical growth until 2030 was one of the primary objectives of the Second National Foresight. Instead of attempting to predict the future, foresight studies sought to lay the groundwork for a process of strategic thinking about the implications of putting potential future options into action. This process involved identifying important trends, opportunities, and risks, evaluating current capabilities, and gauging the state of science and technology in the Republic of Kazakhstan and around the globe [24].

The Foresight methodology comprised the following: a survey of experts from industry, research institutes, and universities; an analysis of internal competencies and resources available for development science and technology; an analysis of patent and bibliometric data; an analysis of current policies, strategies, and programs for scientific, technical, and innovative development; an analysis of road mapping; an identification of critical (key) products and services; and an analysis of technology. Round tables and seminars were held to debate the Foresight results at each major step of the project in order to reach an agreement among all stakeholders, which included government agencies, industry, and academia. The results were also publicized on the organizers' website. A list of scientific subjects that the government should prioritize supporting was suggested, and suggestions for decision makers were created based on the findings of the Second National Foresight. A unique document was created for each of the suggested R&D topics, which included all the pertinent details regarding the topic's nature, novelty and significance, technical features, relevance, and anticipated outcomes, as well as any opportunities that currently exist for the topic's independent development in Kazakhstan or in cooperation with top institutions in the field. Road mapping was done using a prioritized list of R&D subjects. The roadmaps were to be implemented in three phases: an operational plan through 2018, a strategic plan through 2020, and a long-term vision through 2030. There were designated control indicators for every level of the roadmaps. Joint expert group meetings were then arranged to determine the multidisciplinary fields in which Kazakhstan's scientific and technology advancements will take place between now and 2030. National interdisciplinary research initiatives were created as a consequence, and their execution will enable the development of novel technical solutions that sit at the nexus of linked scientific fields [24].

Conclusion

In conclusion, a review of existing scientific and practical approaches and methodologies for foresight research in the development of science allowed us to obtain valuable information on the formation of strategic directions for innovation and sustainability. This analysis illuminated the critical role that foresight research plays in guiding the development of science.

The results of this review highlight several key points: The importance of foresight research: Foresight research is an indispensable tool for predicting future trends and issues in science.

It helps identify new opportunities and threats associated with green technologies, which are vital areas for global sustainability. Cross-border collaboration on predictive research is vital to addressing the complex and interconnected challenges of green technologies and water security.

In Japan, science and technology innovation policies are promoted through the Major Science and Technology Foresight Plans, which have been formulated every five years since 1996 and, as a result, identify upcoming challenges and opportunities, develop effective policies, and ensure a sustainable future for the country. This provides an excellent example of how forward-looking research can inform and shape national science strategies.

In the coming years, it is critical that these regions continue to invest in forecasting research to navigate the rapidly evolving science and technology landscape. Using knowledge gained from predictive research, we can develop evidence-based policies that not only advance scientific knowledge, but also promote a more sustainable and secure future for all. The lessons learned from this review highlight the need for continued commitment to predictive research as a critical driver of progress in science and technology.

REFERENCES

1 Sutherland W., Broad S., Butchart S. A Horizon Scan of Emerging Issues for Global Conservation in 2019 // Trends in Ecology & Evolution. 2018. Vol. 34. Iss.1. P. 1–12. URL: https://doi.org/10.10 16/J. tree.2018.11.001

2 Nakicenovic N., McGlade J., Ma S. Lessons learned for scenario analysis // Ecosystems and human well-being. Island Press, Washington, DC, USA. 2005. Vol. 2. P. 449–467.

3 Norgaard R. The case for methodological pluralism // Ecological Economics. 1989. Vol. 1. Iss. 1. P. 37–57. URL: https://doi.org/ 10.1016/0921-8009(89)90023-2

4 Sutherland W., Broad S., Butchart S. A Horizon Scan of Emerging Issues for Global Conservation in 2019 // Trends in Ecology & Evolution. 2018. Vol. 34. Iss. 1. P. 1–12. URL: https://doi.org/10.10 16/J. tree.2018.11.001

5 Sutherland W., Clout M., Côté I. A horizon scan of global conservation issues for 2010 // Trends in Ecology and Evolution. 2009. Vol. 25. Iss. 1. P. 1–7. URL: https: //doi.org/10.1016/J .tree.2009.10.003

6 Заниздра М.Ю. Методы и практика применения экологического форсайта: аналитический обзор. URL: http://doi.org/10.15407/econindustry 2020.02.093 (дата обращения: 23.08.2023)

7 Каньин К. Форсайт науки, технологий и инноваций в Бразилии. URL: https://www.elibrary.az/docs/jurnal/jrn2014_576.pdf. (дата обращения: 23.08.2023)

8 Bennett E., Peterson G., Levitt E. Looking to the future of ecosystem services // Ecosystems. 2005. No. 8. P. 125–132. URL: http://dx.doi.org/ 10.1007/s10021-004-0078-y

9 Cachia R., Compano R., Da Costa O. Grasping the potential of online social networks for foresight // Technological Forecasting & Social Change. 2007. No. 74(8). P. 1179–1203. URL: http://dx.doi.org/10. 1016/j. techfore.2007.05.006

10 Bishop P., Hines A., Collins T. The current state of scenario development: an overview of techniques // Foresight. 2007. No. 9(1). P. 5–25. URL: http://dx.doi.org/ 10.1108/14636680710727516

11 Bradfield R., Wright G., Burt G. The origins and evolution of scenario techniques in long range business planning // Futures. 2005. No. 37(8). P. 795–812. URL: http://dx.doi.org/10.1016/j.futures.2005.01. 003

12 Brotherton R. The Brain Has a Blind Spot for ‘Unknown Unknowns’ // Discover Magazine. Kalmbach Publishing Company. 2015. URL: http://blogs. discover magazine.com/crux/2015/11/17/brain-unknowns/#. VmFa YISK FFK (eccessed: 23.08.2023)

13 Carpenter S., Bennett E., Peterson G. Scenarios for ecosystem services: an overview // Ecology and Society. 2006. Vol. 11. P. 29.

14 Gidley J., Fien J., Smith J. Participatory futures methods: towards adaptability and resilience in climate-vulnerable communities // Environmental Policy and Governance. 2009. No. 19(6). P. 427–440. URL: https: // doi.org/ 10.1002/ eet.524

15 Cook C., Inayatullah S., Burgman M., Sutherland W., Wintle B. Strategic foresight: How planning for the unpredictable can improve environmental decision-making // Trends in Ecology & Evolution. 2014. No. 29(9). P. 531–541. URL: http://dx.doi. org/10.1016/j.tree.2014.07.005

16 Elgin D., MacMichael D., Schwartz P. Alternative futures for environmental policy planning: 1975–2000 // EPA-540/9-75-027. Stanford Research Institute, Center for the Study of Social Policy for EPA. Washington, USA. European Commission. 2015. URL: http://ec.euro pa. eu/research/index. cfm?pg=foresight (eccessed: 23.08.2023)

17 European Commission. Science for Environment Policy. Future brief: Identifying emerging risks for environmental policies // European Commission. 2016. URL: https://ec.europa.eu/environment/integratio n/ research /newsalert /pdf/emerging_environmental_risks_early_warnings_FB12_en.pdf (eccessed: 23.08.2023).

18 Evans K., De Jong W., Cronkleton P., Nghi T. Participatory methods for planning the future in forest communities // Society and Natural Resources. 2010. Vol. 23. Iss. 10. P. 604–619. URL: https://doi.org/10.1080/ 08941920802713572

19 Gordon T. Energy forecasts using a “roundless” approach to running a Delphi study // Foresight. 2007. No. 9(2). P. 27–35. URL: https://doi.org /10.1108/14636680710737731

20 Leigh A. Thinking ahead: Strategic foresight and government // Australian Journal of Public Administration. 2003. Vol. 62. Iss. 2. P. 3–10. URL: https://doi.org/l0. 1111/1467-8497.00320

21 Foresight and anticipatory governance in practice. OECD 2021. URL: www.oecd.org/strategic-foresight/foresight@oecd.org. (eccessed: 23.11.2023)

22 Leitch J., Leistritz F. Delphi analysis: a technique for identifying and ranking environmental and natural resource policy issues // Environmental Professional. 1984. Vol. 6. Iss. 1. P. 32–40.

23 The 11th Science and Technology Foresight Scenario Planning from the Viewpoint of Globalization // Summary Report - NISTEP REPORT. 2023. No. 183. (eccessed: 23.08.2023)

24 Ким М. Личный блог. URL: https://www.nauka.kz/page.php (дата обращения: 23.08.2023)

REFERENCES

1 Sutherland W., Broad S., Butchart S. (2018) A Horizon Scan of Emerging Issues for Global Conservation in 2019 // Trends in Ecology & Evolution. Vol. 34. Iss.1. P. 1–12. URL: https://doi.org/10.10 16/J. tree.2018.11.001. (In English).

2 Nakicenovic N., McGlade J., Ma S. (2005) Lessons learned for scenario analysis // Ecosystems and human well-being. Island Press, Washington, DC, USA. Vol. 2. P. 449–467. (In English).

3 Norgaard R. (1989) The case for methodological pluralism // Ecological Economics. Vol. 1. Iss. 1. P. 37–57. URL: https://doi.org/ 10.1016/0921-8009(89)90023-2. (In English).

4 Sutherland W., Broad S., Butchart S. (2018) A Horizon Scan of Emerging Issues for Global Conservation in 2019 // Trends in Ecology & Evolution. Vol. 34. Iss. 1. P. 1–12. URL: https://doi.org/10.10 16/J.tree.2018.11.001. (In English).

5 Sutherland W., Clout M., Côté I. (2009) A horizon scan of global conservation issues for 2010 // Trends in Ecology and Evolution. Vol. 25. Iss. 1. P. 1–7. URL: https: //doi.org/10.1016/J .tree.2009.10.003. (In English).

6 Zanizdra M.Ju. Metody i praktika primenenija jekologicheskogo forsajta: analiticheskij obzor. URL: http://doi.org/10.15407/econindustry 2020.02.093 (data obrashhenija: 23.08.2023). (In Russian).

7 Kan'in K. Forsajt nauki, tehnologij i innovacij v Brazilii. URL: https://www.elibrary.az/docs/jurnal/ jrn2014_576.pdf. (data obrashhenija: 23.08.2023). (In Russian).

8 Bennett E., Peterson G., Levitt E. (2005) Looking to the future of ecosystem services // Ecosystems. No. 8. P. 125–132. URL: http://dx.doi.org/ 10.1007/s10021-004-0078-y. (In English).

9 Cachia R., Compano R., Da Costa O. (2007) Grasping the potential of online social networks for foresight // Technological Forecasting & Social Change. No. 74(8). P. 1179–1203. URL: http://dx.doi.org/10. 1016/j.techfore.2007.05.006. (In English).

10 Bishop P., Hines A., Collins T. (2007) The current state of scenario development: an overview of techniques // Foresight. No. 9(1). P. 5–25. URL: http://dx.doi.org/ 10.1108/14636680710727516ю (In English).

11 Bradfield R., Wright G., Burt G. (2005) The origins and evolution of scenario techniques in long range business planning // Futures. No. 37(8). P. 795–812. URL: http://dx.doi.org/10.1016/j.futures.2005.01. 003. (In English).

12 Brotherton R. (2015) The Brain Has a Blind Spot for 'Unknown Unknowns' // Discover Magazine. Kalmbach Publishing Company. URL: http://blogs. discover magazine.com/crux/2015/11/17/brain-unknowns/#. VmFa YISK FFK (eccessed: 23.08.2023). (In English).

13 Carpenter S., Bennett E., Peterson G. (2006) Scenarios for ecosystem services: an overview // Ecology and Society. Vol. 11. P. 29. (In English).

14 Gidley J., Fien J., Smith J. (2009) Participatory futures methods: towards adaptability and resilience in climate-vulnerable communities // Environmental Policy and Governance. No. 19(6). P. 427–440. URL: https: //doi.org/ 10.1002/ eet.524. (In English).

15 Cook C., Inayatullah S., Burgman M., Sutherland W., Wintle B. (2014) Strategic foresight: How planning for the unpredictable can improve environmental decision-making // Trends in Ecology & Evolution. No. 29(9). P. 531–541. URL: http://dx.doi. org/10.1016/j.tree.2014.07.005. (In English).

16 Elgin D., MacMichael D., Schwartz P. Alternative futures for environmental policy planning: 1975–2000 // EPA-540/9-75-027. Stanford Research Institute, Center for the Study of Social Policy for EPA. Washington, USA. European Commission. 2015. URL: http://ec.euro pa. eu/research/index. cfm?pg=foresight (eccessed: 23.08.2023). (In English).

17 European Commission. Science for Environment Policy. Future brief: Identifying emerging risks for environmental policies // European Commission. 2016. URL: https://ec.europa.eu/environment/integratio n/ research /newsalert /pdf/emerging_environmental_risks_early_warnings_FB12_en.pdf (eccessed: 23.08.2023). (In English).

18 Evans K., De Jong W., Cronkleton P., Nghi T. Participatory methods for planning the future in forest communities // Society and Natural Resources. 2010. Vol. 23. Iss. 10. P. 604–619. URL: https://doi.org/10.1080/08941920802713572. (In English).

19 Gordon T. (2007) Energy forecasts using a “roundless” approach to running a Delphi study // Foresight. No. 9(2). P. 27–35. URL: https://doi.org /10.1108/14636680710737731. (In English).

20 Leigh A. (2003) Thinking ahead: Strategic foresight and government // Australian Journal of Public Administration. Vol. 62. Iss. 2. P. 3–10. URL: https://doi.org/l0. 1111/1467-8497.00320. (In English).

21 Foresight and anticipatory governance in practice. OECD 2021. URL: www.oecd.org/strategic-foresight/foresight@oecd.org. (eccessed: 23.11.2023). (In English).

22 Leitch J., Leistritz F. (1984) Delphi analysis: a technique for identifying and ranking environmental and natural resource policy issues // Environmental Professional. Vol. 6. Iss. 1. P. 32–40. (In English).

23 The 11th Science and Technology Foresight Scenario Planning from the Viewpoint of Globalization // Summary Report – NISTEP REPORT. 2023. No. 183. (eccessed: 23.08.2023). (In English).

24 Kim M. Lichnyj blog. URL: https://www.nauka.kz/page.php (data obrashhenija: 23.08.2023). (In Russian).

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ЖАСЫЛ ЭКОНОМИКА БАҒЫТЫНДАҒЫ ЕЛДІҢ ҒЫЛЫМИ ДАМУ СТРАТЕГИЯСЫН ҚАЛЫПТАСТЫРУДАҒЫ ЭКОФОРСАЙТ ЗЕРТТЕУЛЕРІ

Аңдатпа

Бұл мақала жасыл экономика саласындағы елдің ғылымды дамыту стратегиясын қалыптастырудағы экологиялық форсайт зерттеулерінің маңыздылығына бағытталған. Жасыл экономикаға көшу экономикалық өсуді қоршаған ортаны қорғаумен теңестіруді талап етеді, ал теңгерімді үлгіні табу көптеген елдер белсенді түрде жұмыс істеп жатқан күрделі міндет. Экологиялық салада болжау әдістемесін қолдануды көздейтін экофорсайт маңызды инновациялармен және жаһандық экономикалық үрдістермен байланысты табиғи орта үшін ықтимал мүмкіндіктер мен тәуекелдерді анықтауда маңызды рөл атқарады. Зерттеу ағымдағы өнеркәсіптік қызметтің ұзақ мерзімді қоршаған ортаға әсерін бағалауға және жасыл технологияларға қатысты ұлттық өнеркәсіптік саясатты стратегиялық жоспарлауға бағытталған. Сценарийлерді модельдеу, әсіресе жасыл технологиялар саласында, ұзақ мерзімді көкжиектер мен көптеген белгісіздіктерге байланысты экологиялық болжамның маңызды аспектісі. Мақалада жаһандық стратегиялық үрдістер контекстінде тұрақты даму мен инновацияларды қамтамасыз етудегі экофорсайт зерттеулерінің маңыздылығы атап өтілген.

Тірек сөздер: форсайт, жасыл экономика, Дельфи әдісі, модельдеу, ғылымды дамыту, экофорсайт, экологиялық жоспарлау.

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ЭКОФОРСАЙТ-ИССЛЕДОВАНИЕ В ФОРМИРОВАНИИ СТРАТЕГИИ РАЗВИТИЯ НАУКИ СТРАНЫ В ОТНОШЕНИИ ЗЕЛЕНОЙ ЭКОНОМИКИ

Аннотация

В данной статье акцентируется внимание на важности экофорсайт-исследований в формировании стратегии развития науки страны в сфере зеленой экономики. Переход к зеленой экономике требует балансирования экономического роста с сохранением окружающей среды, а поиск сбалансированной модели – сложная задача, над которой активно работают многие специалисты страны. Экофорсайт, предполагающий использование методологии форсайта в экологической сфере, играет решающую роль в выявлении потенциальных возможностей и рисков для природной среды, связанных со знаковыми инновациями и глобальными экономическими тенденциями. Исследование направлено на оценку долгосрочного воздействия текущей промышленной деятельности на окружающую среду и стратегическое планирование национальной промышленной политики в отношении зеленых технологий. Сценарное моделирование, особенно в области зеленых технологий, является важным аспектом экологического прогнозирования из-за его длительных временных горизонтов и многочисленных неопределенностей. В статье подчеркивается важность экофорсайт-исследований в обеспечении устойчивого развития и инноваций в условиях глобальных стратегических тенденций.

Ключевые слова: форсайт, зеленая экономика, метод Дельфи, моделирование, развитие науки, экофорсайт, экологическое планирование.