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Digital Technologies and the Green Economy: Prospects and Challenges

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Abstract: The transition to the post-industrial phase of world development is accompanied by the aggravation of global problems that can be solved within the framework of digital technologies and the green economy. The main principles of such an economy respond to modern ideas about balanced development and in many ways are similar to the rational environmental concept. Digital technologies and the green economy are based on the idea of improving the quality of life of the population and economic growth while reducing the burden on the environment. The digitalization and green economy indicators developed so far reflect the difficulty of comprehensively assessing the economic, environmental, and social consequences of development. Due to the lack of a generally accepted approach to such assessment, the development of the world and national economies is often compared to the dynamics of their energy capacity or resource capacity, taking into account the "life cycle" of products, which makes it possible to more objectively distribute the responsibility of countries for environmental damage.

Keywords: green economy; digital technologies; digitization; renewable energy sources; green technologies

JEL Classification: Q55; Q56; Q57; F15

1. Introduction

In scientific circles for the last decade, it has been argued that traditional economic models need to be reformed to solve the problems of climate change, biodiversity destruction, water scarcity, etc. problems, and key social and economic problems will also be solved with it. The current financial crisis in 2008-2009 led to a debate on this issue (Barbier, 2010), the importance of which became especially relevant in the context of the global crisis arising from the ongoing hostilities in Ukraine, which was reflected in the concept of the green economy (Merino-Saum et al., 2020; Söderholm, 2020; Claire, 2023). The report "Global Green New Deal" published by the United Nations Environment Program discusses the goals, objectives, elements, incentives, and directions for the development of a green economy (UNEN, 2019).

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The essence of the green economy is often defined as a practical approach to achieving sustainable development. And the experts, when they talk about the green economy, especially note that it is important and necessary to invest in green technologies for its development (Relander, 2022).

The common agenda for achieving sustainable development (Paris and Glasgow conferences) is based on common goals such as green growth and a green New Deal. The role and importance of digital technologies in the process of development of green economy causes opposite opinions among scientists. In general, the role of digital technologies in reducing non-environmental energy in the economy is limited. Digital technologies can, in their activities or in the life cycle of their products, increase efforts to increase their energy efficiency and use renewable energy sources. However, energy consumption in the sector is a relatively small part (4-9%) of the total electricity consumption in the economy (United Nationals. Paris Agreement, 2015; United Nationals, 2021). It is from this that the concepts of sustainable development, resource-saving production, and green economy arose and are developing (Anon, 2019; Nekrasova, 2017).

According to the Organization for Economic Cooperation and Development (OECD) classification, green technologies include (Tecam, 2023):

• ecology management (waste management, water and air pollution control, etc.);

• Energy production from renewable sources (solar energy, wind energy, biofuel, etc.);

• Mitigation of climate change;

• reduction of harmful emissions in the atmosphere;

• improving the efficiency of fuel use;

• Improving the energy efficiency of buildings and lighting equipment.

2. Global Market of Green Technologies: Structure and Development Trends. (Empirical Data and Discussion)

"Green economy" belongs to "sustainable development technologies" (Heshmati, 2018). The "green economy," like the term "sustainable development" that encompasses it, is not a strictly defined precept, but a more global agenda. Since the beginning of the 2010s, experts from the Preparatory Committee of the United Nations Conference on Sustainable Development, held in Rio de Janeiro in 2012, and the United Nations Environment Program (UNEP) have put the "green economy" in the context of the concept of sustainable development and defined it as an economic activity that reduces environmental degradation and risks of depletion of nature and aims to increase welfare and social justice (Brand, 2012).

The idea of a green economy or "green growth" is a generalization of several approaches to the inclusion of the ecological factor in economic development indicators and a direct consideration of the contribution of nature and natural resources to economic growth. This is primarily the assessment of national wealth developed by the World Bank as a combination of human, natural, and renewable capital and its operationalization as an adjusted net savings index (Lange et, al, 2011), as well as the concept of ecosystem services of the economy developed by Under the aegis of UNEP (Assessment, Millennium Ecosystem, 2005). These approaches significantly modify the representation of economic growth even in detail.

Today's global trends include the transition to a "green" economy based on the principles of combining public interests and preserving natural capital. Therefore, one of the key directions of technological development in the world is the development of so-called "green" technologies, which allow to ensure the necessary level of economic growth without creating additional environmental risks (Kenton, 2022).

"Green technologies" are the result of IT solutions aimed at preserving nature. The most obvious and easily understood examples are energy conservation and renewable energy sources, recycling and reuse of materials, and wastewater treatment (Crew, 2022).

Sooner or later people will come to the necessity of using "green" technologies (Safdie, 2023). The current consumption of natural resources is at the expense of our planet, and future generations will have a much smaller supply of raw materials to sustain life. Therefore, it is worth thinking about the future now - the trend of preserving nature in every possible way is very relevant today. Scientists are sure that the introduction of "green" technologies will happen, and all over the world. In many areas, options are already being developed to effectively replace certain resources with less expensive but also environmentally friendly resources.

In 2009, the countries of the Organization for Economic Cooperation and Development adopted an ecologically oriented (green) growth strategy as a tool for overcoming the financial and economic crisis in the medium-term (until 2030) and long-term (until 2050) perspectives. South Korea has become a pioneer in the transition to a green economy, declaring green growth as its national strategy. After South Korea, China also took the course on green economy. And then the EU countries started to transition to green development (OECD, 2011).

According to experts, the global green technology market was estimated at 575 billion USD in 2022, and it is expected to reach 880 billion USD by 2032, with a growth of 4.4%, which is almost 2 times the growth rate of the global economy.

The chart below shows the actual value of the global green technology market volume in 2022 and its growth forecast until 2032 (see Figure 1).

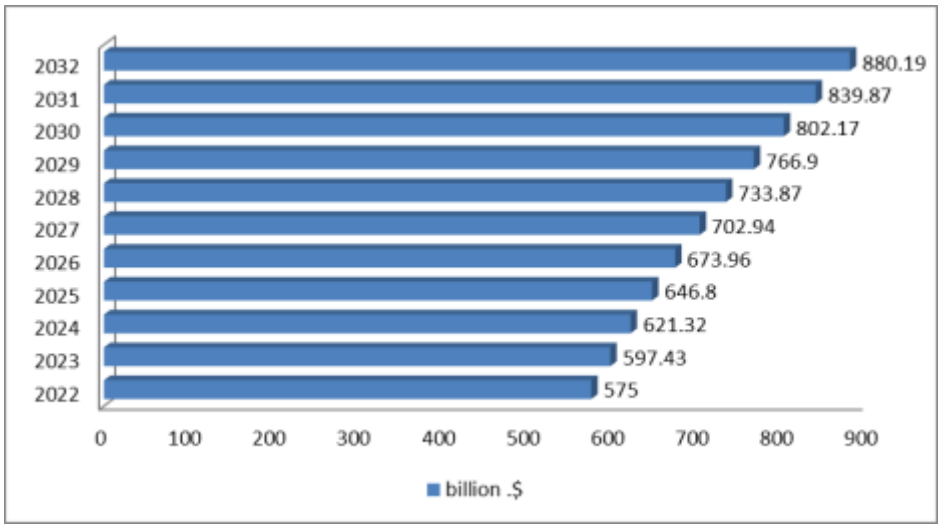


Figure 1. Green Technology Market Volume in 2022-2032 (in Billions of $)

Source: Chart based on data from Environmental Technology Market Size, Share, Report 2022-2030.

If we analyze the data on the structure of the green technology market, we can note that its two main segments are environmentally friendly production, energy storage and distribution, and the energy efficiency submarket. Segments such as environmentally sustainable mobility and efficient use of raw materials are predicted to grow by 2025 (see Figure 2).

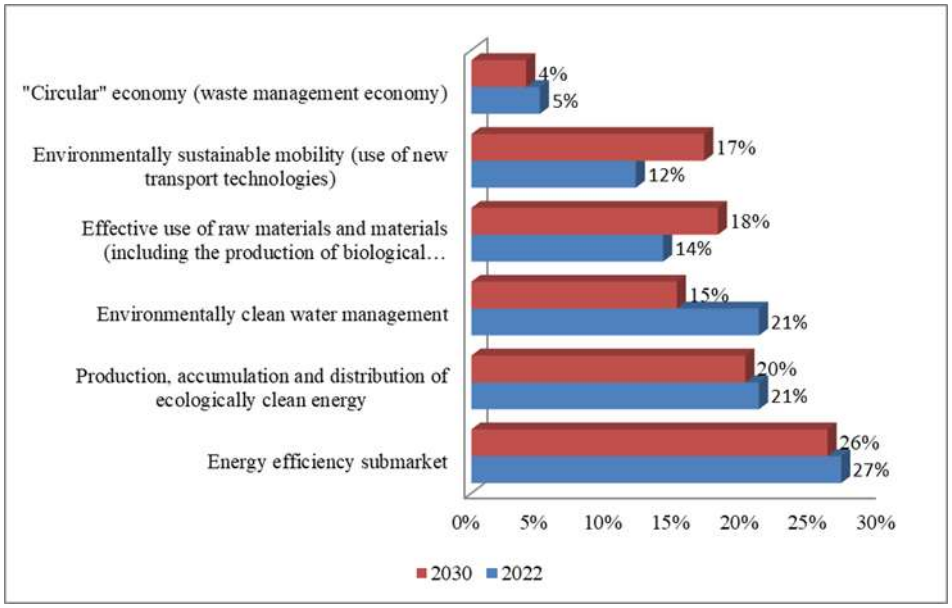


Figure 2. Green economy market 2022-2030 (Grand View Research, 2023)

It should be noted that the global mission of the green growth strategy is to increase the efficiency of the use of existing resources and the formation of environmentally friendly production systems.

The goal that international organizations and national governments have set for the transition to green standards is to improve the productivity of existing resources and the environmental performance of industrial companies in developing and developed countries and to promote the sustainable development of industry and consumption.

Accordingly, it is about integrating the environmental goals of business and long-term sustainable development, creating economic opportunities, as well as finding innovative ways for business, which will create an economic-industrial basis for the further evolution of an ecologically oriented economic system.

The essence of green development, in our opinion, is to increase the efficient use of resources and the scale of clean production operations, incorporating them into "sustainable", and "green" cities and, in the long term, "sustainable" national and ideally global economic systems. In such economic systems, economic and social symbiosis can be achieved in all aspects of sustainable planning: for example, waste streams can be exchanged at the regional level using a wide range of infrastructure, logistics, and recycling, as well as turning them into a cheap energy source (which will also be a renewable resource).

3. Possibilities of Formation and Development of Green Economy in National Economies

According to the fundamental tenets of economic theory, each manufacturing company operating in the market tries to optimize its activities to obtain the best financial result and maximum return from the existing factors of production. A set of similar economic entities operating in highly competitive markets can theoretically ensure the optimal level of resource exploitation. However, in reality, the picture is much more complicated.

So, it is necessary to take into account the existence of external effects, the imperfection of the specification of property rights, as well as the existence of not only the optimum of the firm but also the optimum of a higher level, which is related to the functioning of a set of various economic entities, including the functioning of the economic system of a country and groups of countries.

At the same time, a more global task should be set - to turn the entire agricultural system of the country into a kind of eco-technopark. However, it is necessary to make an important reservation - the transformation of the economic structure of a particular industry, region, or country is unlikely to have a significant impact on the ecological situation. However, taking into account that the economic systems of the largest countries - India and China - have taken a course on building a green economy, and the economies of Germany, Sweden and Scandinavian countries have been following this course for a long time, the sustainable development of the economy of Georgia needs to join the camp of countries with a "greening" economic system (Mukhugulashvili, et al. 2022).

When thinking about modern production and the process of its conversion to green technologies, it is necessary to take into account that for its organization and optimization, it is necessary to form a unity of the following components, such as:

1. financial and economic;

2. organizational;

3. information-technological;

4. personnel;

5. Infrastructural;

6. Spatial.

Therefore, increasing the productivity of economic resources, a very urgent task, requires increasing the efficiency of all components of the production process.

Nevertheless, the most important can be called the financial and economic component, to which (with a certain, very important, degree of conditionality) we can attribute production capital, which exists in both materialized and monetary form since it is the material basis for the realization of technology and the production process. The financial and economic base of the production process is one of the most intensive operating components of the production process. Increasing the efficiency potential of using the financial base of the production process implies the need to optimize its following components:

• Optimization of materialized capital implies, first of all, optimization of the structure of fixed assets and mainly production equipment.

• Optimization of the depreciation policy, which will allow economic entities to gradually replace production equipment with new ones that meet the standards of the green economy.

• Introduction of digital management systems, which allows economic processes in enterprises to be managed in a more economical mode and, accordingly, will increase the productivity of resources.

Thus, the intensification of production is closely related to the use of resource-saving technologies, within which not only economic benefits but also ecological effects are manifested. Information technology is of great importance here, which provides the collection and processing of a large amount of data, which also makes it possible to qualitatively change approaches to the implementation of economic activities of organizations.

4. Digital Technologies and their Impact on the Green Economy

The transition to green economy standards is complicated for Georgia, since the fact that the main contribution to economic growth is made by the mining and processing industry, and not by high technologies, is a feature of the national economy, and therefore, the impact on the environment remains quite large. For the government of Georgia, in the process of the country's economic development, one of the important tasks is the digitalization of the economic system and the transition to a green economy.

In the modern world, the topic of ecological economy is one of the most growing trends in the last few years. In Georgia, the environmental problem occupies one of the main places in the list of problems facing the country at the modern stage. According to a Yale University study, as of 2022, Georgia ranks only 103rd in the Environmental Performance Index, which measures the country's achievements in environmental and natural resource management based on 32 indicators in 11 categories (Yale University, 2022).

One of the main ways of "greening" the economy can be considered innovations and the introduction of new technologies (including digital technologies) in various fields of activity. In 2020, after the rapid transition of many companies to the digital plane, the stage of fundamental transformation of the economy began.

To measure the level of digital economy and digitization in a country, it is necessary to analyze several factors, namely: the level of Internet penetration, the level of development of digital infrastructure, e-business activity and e-government services. There are also international indices, according to which the level of digitization in the country can be determined. One such important index is the Global Electronic Government Index (E-Government Development Index (EGDI)) published by the United Nations. It shows the state of development of e-government of the UN member states. and consists of three important components, namely: the online service delivery index, telecommunication infrastructure index, and human capital index. The diagram compares the data of some EU countries, Ukraine and Georgia in the mentioned index, it covers the years 2014-2024 (E-Government Survey 2022) (see Figure 3).

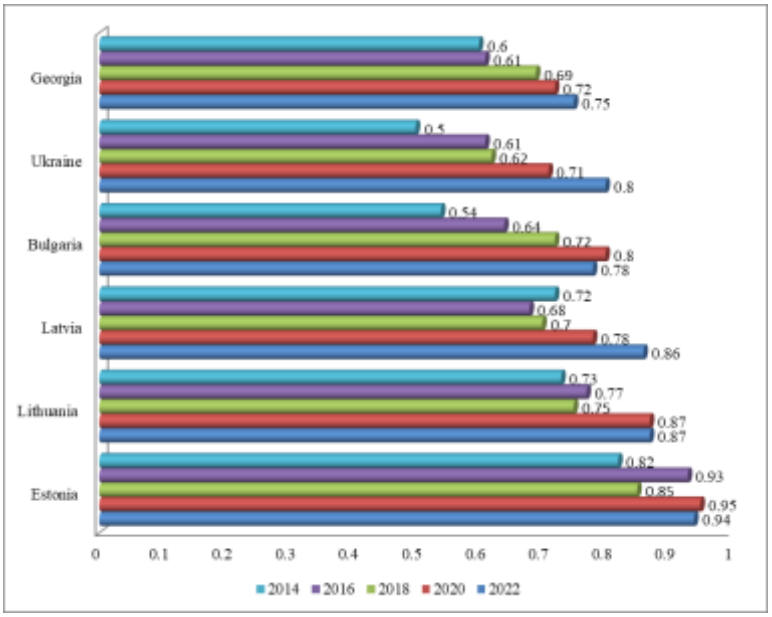


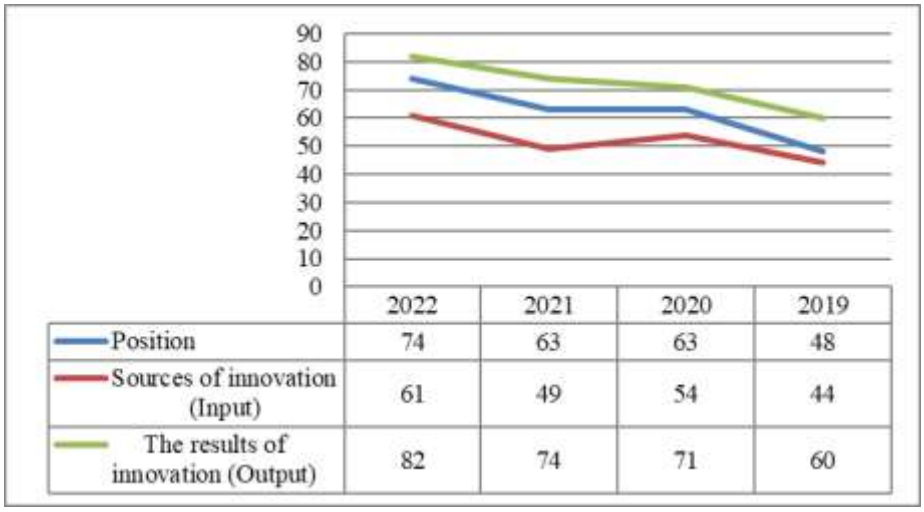
Figure 3. Global e-Government Index

Source: Chart based on data from the E-Government Development Index (EGDI).

As we can see in the diagram, Georgia's position in this index improved by 15 units in 2022 compared to 2014. Despite this, it lags behind both the Baltic states and Ukraine and occupies the 60th place. It should be noted here that in this index, all EU countries have a higher score than Georgia.

The level of development of the green economy is also indicated by the global innovation index. 80 indicators are used in its calculation, they are grouped into innovative sources and results (see Figure 4).

As can be seen from the diagram, in 2020 compared to 2019, the situation of the country worsened by 26 positions in the mentioned index. i.e. According to the index, Georgia is unable to effectively transform investments in innovation into significant results corresponding to the scale of investment and is included in the list of "inefficient" countries. which significantly hinders the development of the green economy in the country.



	2022	2021	2020	2019
Position	74	63	63	48
Sources of innovation (Input)	61	49	54	44
The results of innovation (Output)	82	74	71	60

Figure 4. Georgia's Position in the Global Innovation Index

Source: Chart based on WIPO Global Innovation Index data

Also, for the establishment and further development of the green economy in the country, one of the crucial importance is given to the Internet coverage of the entire territory. According to the data of the National Statistical Service of Georgia, 88.4% of households in the country had access to the Internet in 2022 (Sakstat 2023). In cities, the similar rate is 92.8%, and in the rest of the territory, 82.4%. We should note here that this indicator has increased by 18.3% compared to 2016. The chart below shows the Eurostat indicators of Internet access for households, where it can be seen that the average value of this indicator in the European Union is 92.48%. With the same indicator, Georgia is ahead of such countries as Bulgaria (87.31%), Romania (87.71%), Serbia (83.4%), and Montenegro (80.96%), but is behind Turkey (94.15%). It should also be noted that Eurostat and Saxstat survey data may differ, which may also show a different picture (see Figure 5) (Eurostat, Level of Internet Access – households).

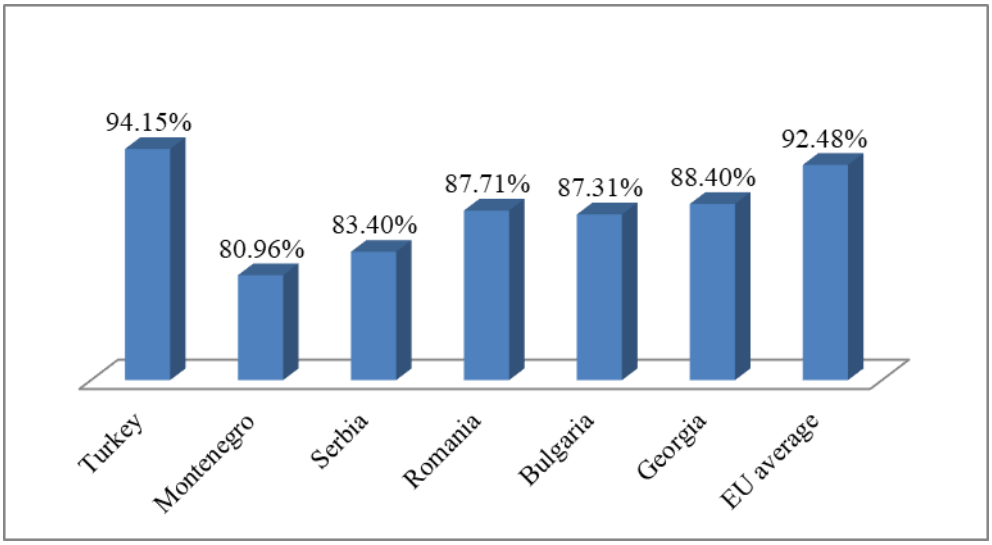


Figure 5. The Internet access rate of households in 2022.
Source: The chart is based on Geostat and Eurostat data

Thus, the Georgian government still has a lot to do to raise the level of digitization in the country, which has a somewhat significant impact on the development of the green economy in Georgia.

According to a study by Oxford University's Global Recovery Observatory, supported by the United Nations Environment Program (UNEP), environmental issues account for less than 20% of total recovery costs (Oxford University Economic Recovery Project, 2021). Every year, UN conferences are held where all important issues related to climate change and environmental degradation are discussed, and all important decisions are made in this field. The following agreements were adopted at the 26th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26) (United Nations. Climate Action, 2021):

1. End deforestation by 2030.

2. To reduce the release of methane (this commitment was supported by about a hundred countries, but the main polluters - China, Russia, and India - did not agree to such conditions).

3. Global agreement on the phase-out of coal use (China, Russia, and the United States did not sign).

At the modern stage, world business directs significant resources to the development of technologies aimed at preventing climate change and reducing environmental pollution. The development of alternative energy technologies is one of the most powerful drivers of innovative development. Alternative energy sources include renewable energy resources that are obtained using hydropower, wind energy, solar energy, geothermal energy, biomass, and tidal energy. Unlike fossil fuels such as oil, natural gas, coal, and uranium ore, these energy sources do not decay, which is why they are called renewable (Climate Consulting, 2022). In recent years, the total capacity of energy generation facilities in Georgia has been increasing, but the rate of development is significantly lower.

5. Conclusion

Thus, to transition to a green economy in Georgia, it is first all necessary to form a new production base, as well as to introduce digital management systems, at the expense of materialized capital and depreciation policy optimization. The main goal is to increase the productivity of resources and ensure the saving of resources. In addition, the ability of countries and economic complexes to attract green

investments is of crucial importance. These investments are formed in the process of transition to a socially oriented direction of business management.

The successful transition to the green economy is facilitated by several measures adopted by the countries at the national and international levels, among which the introduction of digital technologies occupies an important place. During the development of the green economy in various sectors, the following main directions can be identified, the implementation of which in Georgia can help to improve the overall economic efficiency:

1. State investments and expenses (optimization of expenses in the field of digitalization of green economy and management processes).

2. Use of environmental taxes and other market instruments that reduce environmental externalities and compensate for market weaknesses in this regard.

3. Reforming environmentally harmful budget subsidies (restriction of government support for industries that do not use natural capital).

4. Improvement of the legal framework in this regard.

5. Digital technologies can improve the efficiency and reliability of the green sector of the economy, as well as help save energy.

6. The development of digital technologies and the green sector together, of course, helps to increase the efficiency of the process of implementation of sustainable development goals.

7. Development of international cooperation in the field of digitization of ecology, resource use, and management processes.

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