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RESEARCH AND ANALYSIS OF INTERNATIONAL PATENT ACTIVITY IN THE FIELD OF GREEN TECHNOLOGY

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Abstract

The subject matter of this article is the green technology and its protection as intellectual property objects, more particularly as invention. The analysis will focus on green technology in agriculture and the economic development of the countries over the last two decades due to these technologies. The article indicates the essence of green technologies and the areas of application of the technology, mainly in agriculture. A profile of the enterprises developing green technologies has been made. The results of the performed patent research are analysed, and the top applicants/owners of patents are identified. The filed national and international applications for inventions and the issued patents in the field of green technologies are deduced on country/territory bases. The Influence of green technologies on the development of new plant varieties is also analysed. The thesis of the present study is that one of the important factors for achieving and maintaining economic development and competitiveness of enterprises in today's competitive environment is the creation of innovative products in the field of green technology and their protection as a patent for an invention.

Keywords: green technology, agriculture, inventions, patent protection, intellectual property, economic development

JEL: Q10, O30

Introduction

Our ecosystem is facing serious threats and challenges – increasing population, climate change and soil degradation. For example, avoiding the most catastrophic impacts of climate change will require an urgent and substantial reduction of greenhouse gas emissions over the coming decades (Suh et al., 2017). Furthermore, because many natural ecosystems are under threat, they will need active support if they are to avoid collapse and to avert widespread species extinction (WIPO, 2022). The world's biological resources and ecosystems are limited, so

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efforts are needed and innovative approaches to feed the growing population and provide clean water and energy. Green technology can turn seaweeds into fuel, recycle plastics, produce furniture or clothing from waste, and create biofertilisers from waste products from industrial production. Bioeconomy and green technology are also a key area for stimulating growth in rural areas. Contemporary achievements in our country are related to the use of modern technological methods based on the chemical, biological and engineering science (Markova, 2007).

Farmers, fishers and aquaculture producers need to transform their production methods more quickly, and make the best use of nature-based, technological, digital and space-based solutions to deliver better climate and environmental results, increase climate resilience and reduce and optimize the use of inputs (e.g. pesticides, fertilisers) (European Commission, 2020). Other energy efficiency solutions in the agriculture and food sectors should also be considered. This transformation could happen by the use of innovations in the field of green technologies that could be protected by patents for inventions.

The aim of the research is to determine the nature of green technology, the areas in which the technology is used and to identify patent protection. In addition, the purpose is to analyze the applicants' activity and the patents granted in an international aspect.

In this paper, patent research is performed for filed patent applications and granted patents in the field of green technology. The search is conducted according to a specific patent research methodology.

The thesis of the present study is that one of the important factors for achieving and maintaining economic results and competitiveness of enterprises in the field of agriculture is the creation of innovative products related to green technology. These products should be protected as patents for invention.

Limitations – only filed patent applications and patents granted for green technologies will be considered and analyzed in the article. The protected results as utility models, industrial designs, trademarks, copyrights, or any other intellectual property (IP) right will remain outside the scope of the article.

Green Technology

Essence and areas of application

The subject matter of this article is the green technology and its protection as intellectual property objects, more particularly as invention.

Green technology is a term that describes the use of technology and science to reduce human impacts on the natural environment. The term is linked to biodiversity as the later encompasses those parts of the economy that incorporate renewable biological resources (such as forests, crops, animals, and microorgan-

isms) to produce food, materials and energy. The development of the bioeconomy depends on the use of new technologies and leads to great applicable results by combining bio and engineering sciences. These results must be protected as intellectual property, namely as patents for inventions, in order to return the investment of the creator and to support the development of new innovation.

In the last two decades the legislation in the field of biodiversity and green technology has quickly developed. The concept of bioeconomy was first introduced in 2005.

The European Green Deal for example was introduced by the European Commission in 2019 and sets out how to make Europe the first climate-neutral continent by 2050 and to reduce the car emissions with 55% by 2030. It also maps a new, sustainable and inclusive growth strategy to boost the economy, improve people's health and quality of life, care for nature, and leave no one behind (European Commission, 2019).

One year later another strategy was presented as one of the key actions under the European Green Deal. The Farm to Fork Strategy is a new comprehensive approach to how Europeans value food sustainability (European Commission, 2020). It is indicated in the Strategy that there is an urgent need to reduce dependency on pesticides and antimicrobials, to reduce excess fertilization, increase organic farming, improve animal welfare and in that way reverse biodiversity loss. Another important aspect is that the food system is under constant threat, and it should become more sustainable in the future.

In order to achieve the above aims the business should use innovations and protect them as IP, more specifically as patents for inventions.

It should be noted that the green technology could find application in any industry, however the areas in which the technology is currently most widely used are:

- Agricultural products – food and beverages;
- Genetic resources;
- Fertilizers.

The article is focused on green technology in agriculture, namely:

Class A from the International Patent Classification (IPC) – Human necessities; Agriculture more specifically:

A23: Food or Food Products;

A23 F: Cafe; Tea; Their Substitutes; Their Manufacture or Infusion.

Countries such as China, the United States, Japan, and South Korea are investing billions in the development of green technology and the training of skilled specialists.

Protection of the results of the green technology as inventions

Companies use different ways to protect green technologies as IP. A patent for invention is granted for methods, processes, technologies, chemical compounds (chemically derived substances) and bio technological inventions (Todorova, 2020). The study includes examples from practice that allow a deeper understanding of the issues related to green technology in the international aspect.

In the present article, the results of green technology will be considered and the way in which they are protected as objects of industrial property, in particular as inventions.

An invention is a novelty created in the field of science and technology (Borisov and Borisova, 2015). In order to be protected with patent, the invention should be worldly new, applicable and should have inventive step (Borisov, 1999). Legal protection over a patentable invention is granted by a patent for invention for 20 years. Once issued, its holder receives exclusive rights to the patentable invention, which include the right to use the invention, the right to dispose (to grant licenses or sell it to another party) and prohibit others from using the invention without the consent of the patent owner. This right is a monopoly right, however after the expiration of this term, the patent becomes publicly available. In other words, IP is the balance between the private interest of the creator/inventor, and the public interest of the consumers (Petrova, 2020).

Research Methods

In the present article a patent research will be performed for patent applications and/or patents granted for inventions according to the methodology for conducting patent studies set by Prof. B. Borisov in "Methodology for patent research", Sofia, UNWE, 1999.

The research was carried out for results in the field of green technology. When searching in title, abstract and claims, a total number of 16 185 results have been identified. Due to the enormous number of results, the search has been limited to key words only in the title and abstract. The analysis methods used are the comparative method, structural method, and statistical data analysis. The findings are presented in a tabular form, through diagrams and graphics.

Determining the parameters of the patent search

Purpose of the patent research

This patent research aims to identify the filed patent applications and granted patents in the field of green technology internationally.

Subject of patent research

The subject of the research is filed applications for inventions and granted patents in the field of green technologies, applied before the Patent Office of the Republic of Bulgaria (BPO), the European Patent Office (EPO), the World Intellectual Property Organization (WIPO), the Chinese Patent Office, the United States Patent Office (USPTO), as well as the Office of South Korea.

Countries covered by the survey

The territories covered by this research are Bulgaria, China, the USA, South Korea, PCT applications for inventions filed with WIPO, and European patent applications filed with the European Patent Office. Except for Bulgaria, the countries that the research covers were selected because these territories have the highest number of filed patent applications and patents granted in the field of green technologies.

Depth (retrospective) of the patent research

The patent research covers the period from 01 June 2002 to 01 June 2022 or a total of 20 (twenty) years. The patent research has been carried out for a period of twenty years, since the term of protection of the invention is twenty years and after its expiry it becomes freely available to the public, and at the same time the concept of bioeconomy was also first introduced almost 20 years ago.

Information sources

The following online databases were used to implement this patent research:

• The online database of the Patent Office of the Republic of Bulgaria[1].

• The online database of the European Patent Office (European Patent Register)[2].

• The Espacenet online database – a database coordinated by the EPO in close cooperation with the EPO Member States. More than 110 million patent documents are available worldwide[3].

• Lens online database – this database provides access to more than 117 million patent documents in over 95 jurisdictions[4].

This research covers only filed applications for inventions and granted patents in the field of green technologies that are published in the publicly accessible online patent databases listed above. Due to the fact that the publication of the ap-

[1] See website of the Bulgarian Patent Office.

[2] See website of the European Patent Office.

[3] See website of Espacenet patent database.

[4] See website of Lens patent database.

plied invention is on the 18th month following the submission of the application, the latest documents still could not be available at the databases.

Classification of the subject of patent research

For the purposed of the present patent search, we shall use the International Patent Classification (version of the IPC dated January, 2022). Regarding the analyzed results of filed patent applications and granted patents in the field of green technologies, it should be pointed out that not all patent applications can be classified in the same section of the International Patent Classification. When analyzing the results of filed patent applications and granted patents in the field of green technologies, it should be considered that patent applications are most often classified under

Section A – Human needs; Agriculture and more specifically:

- A23 Food or food products;
- A23F Coffee; Tea; Their Substitute; Their Manufacture or Infusion.

Analysis of the results from the performed patent research

As the main type of search, a subject search was performed on the already established subject matter of the patent research. The subject matter of the research are the filed applications and patents obtained for inventions in the field of green technologies.

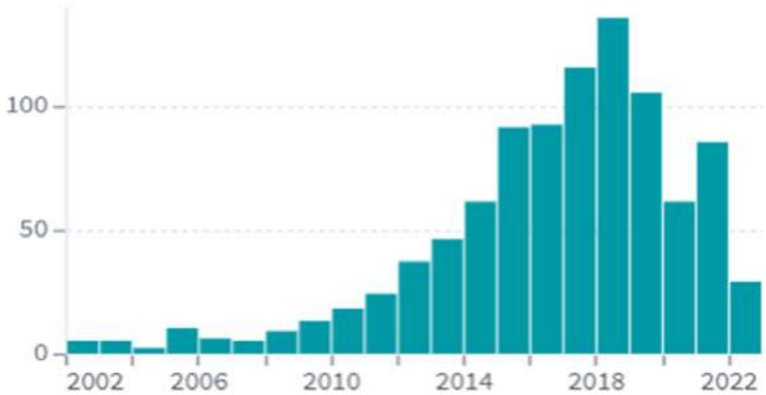
A quantitative search was carried out for each year and by subject matter for the period 01 June 2002 to 01 June 2022.

The information has also been systematized by year and country and by the number of filed patent applications and granted patents by the respective applicants and patent holders.

The number of patent applications, filed in the above-mentioned period is 886 and the number of granted patents is 68.

For 2002 and 2003 there were five filed patent applications, while for 2004 and 2005 – two and ten results were identified respectively. For 2006 there were six published documents (total applications filed and patents granted), for 2007 – five, for 2008 – nine and for 2007 – four results were identified. For the following years, the results are as follows: for 2008 there were a total of five filed applications and granted patents, for 2009 – thirteen, for 2010 – sixteen and for 2011 – 24 results. Since 2012 there has been an increasingly accelerated trend in application activity, with 37 documents published in 2012, 46 results in 2013, 61 results in 2014, 91 results in 2015, and 92 results in 2016. The highest applicant activity in the subsequent years, with 115 documents identified for 2017, 135 results identified for 2018, and 105 results found for 2019. In the following years,

the application activity decreased, with 61 documents found for 2020, 85 for 2021, and 29 applications filed and patents granted for the first half of 2022.



Source: Calculations based on results of patent searches in online databases The Lens

Figure 1: Publications per year

Based on the results of the research, we could conclude that in the first years of the research period (from 2002 to 2008), the number of published patent applications and granted patents in the field of green technologies was extremely low. In the period from 2009 to 2011, the activity of patent applications has increased and since 2012 we observe an accelerating trend. This applicant activity can be explained by the global introduction of green technology, as well as the impact this technology has on modern society.

According to the results in the table presented below, the territory of China has the highest number of patent applications and granted patents in the field of green technologies. Considering China's clear leading position, with 879 documents published, it can be concluded that the country is prioritizing green technologies and investing sufficient resources to obtain patent protection for the results obtained. In the second place after China is South Korea, with a total of 24 patent applications and granted patents. South Korea is followed by the USA with 19 applications filed, then WIPO with 9 PCT results, and the European Patent Office with a total of 7 applications. No results were found for the territory of Bulgaria. It should be considered that the most probable reason for the zero results is not only the low applicant activity but also the fact that some of the filed patent applications are recent and have not yet been published in the available

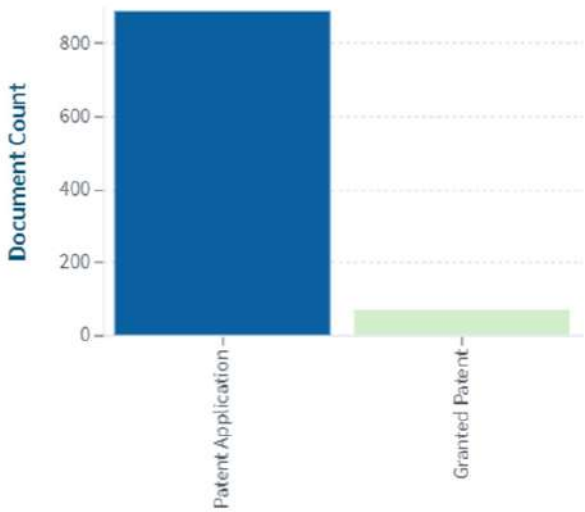
databases. Another reason could be the fact that utility model protection is the most common way for protecting innovations in Bulgaria.

Table 1: Total number of applications filed, and patents granted for inventions by Country / Patent Office

Country / Office	Applications filed and patents granted
China	879
South Korea	24
The USA	19
WIPO	9
EPO	7
Bulgaria	0

Source: Calculations based on results of patent searches in online databases The Lens

The correlation between filed patent applications and granted patents for the period 2002 – 2022 is shown in Figure 2.



Source: Calculations based on results of patent searches in online database The Lens

Figure 2: Patent filed applications and granted patents for 2002 – 2022

During the relevant period, patent applications for the territories of China, the USA, South Korea, PCT applications filed with WIPO, and European applications filed with the EPO totaled 886, and 68 patents were granted.

Table 2 shows the applicants with the highest number of applications in the field of green technologies, as follows:

- Lu Yongzhu – 7 patent applications filed and patents granted;
- Sui Pixiang – 7 results;
- Dadangand Co LTD – 4 results;
- Univ Cornell – 4 documents published;
- Anhui Province Jinzhai County Jinlong Yuzhu Tea Ind Company LTD – 3;
- Anhui Tianfang Tea Group Co LTD – 3;
- Blue Whale Hangzhou Culture Tourism Dev Co LTD – 3;
- Guangxi Nanning Paiteng Technology Co LTD – 3.

Table 2: Applicants with the highest number of applications filed in the field of green technologies

Source: Calculations based on results of patent searches in online database The Lens

Results and discussions

After analyzing the results of the research, we can conclude that the application activity internationally of companies in the field of green technologies is low to medium. Since 2014, there has been an increase in patent applications and granted patents, reaching a peak in 2019, for a total of 135 patent applications and granted patents.

When analyzing the results of the survey, the first position is occupied by China with 879 published results, and the second position is occupied by South Korea with a total of 24 filed patent applications and granted patents. Between the first two countries, there is a very large difference, with China having an edge over the other observed territories, especially considering that the total number of filed applications and granted patents is 954 in total.

With regard to the lack of results for the territory of Bulgaria, we could conclude that Bulgarian companies do not apply for patents for their technological developments in the field of green technologies. It would be better for them to invest more in R&D and in creating developments in the field of green technologies, given the global prosperity of this field. At the same time, several Bulgarian enterprises freely use foreign inventions that have not received patent protection on the territory of Bulgaria or use patented inventions from foreign companies for which they have acquired licenses.

Green technologies also influence the plant varieties and animal breeds through the use of innovative methods and improved fertilizers for their cultivation. Below are some examples of granted patent for inventions:

- Method for extracting crude palm oil using green technology;
- Green raising technology for domestic pig;
- Treatment of growing trees or plants, e.g. for preventing decay of wood, for tingeing flowers or wood, for prolonging the life of plants;
- Green chemical technology for producing chloracetyl chloride;
- Green technology for crosslinking molecules for various uses;
- Green non-pollution synthesis technology for garlic oil.

For the 20-year period, covered by the survey, the total number of patent applications and granted patents in the field of green technologies for the territories of China, the USA, South Korea, including those filed internationally at WIPO and regionally at the EPO, is 886, and the total number of granted patents for inventions is 68 (or 954 in total).

Regarding the analysis of the origin of the applicant and patent-holding companies in the field of green technology, Chinese applicants such as Lu Yongzhu, Sui Pixiang, and others take the lead.

Conclusion

In the future, green technology will find an even greater application worldwide, as the areas in which the technology is used are growing with each passing year.

The climate and environmental aims of the Green Deal could be achieved by a sustainable food system. The business should find the way for the transformation of waste, residues and unusable objects into high-value products, environmentally

friendly chemicals, animal feed and textiles. Scientific research and innovation have a key role to play in accelerating green economy and achieving the sustainable development goals.

Granting patents for their inventions ensure the farmers a fair economic return for their efforts to improve the management of natural resources. The innovations in the field of green technology will lead to: (1) improving living conditions, (2) maintaining a healthy environment, (3) ensuring sustainable energy resources. The role of inventions in green technology is of great importance to society. Inventions solve various problems in the field of science and technology, which lead to the development of the technological progress in the whole world.

The companies should be stimulated in various ways to create new technologies that could be used in agriculture. Actions that could be undertaken in order to stimulate the business to create and register IP, are for example: development of a legislation framework for a sustainable food system; opening new programs covering the costs for the IP protections; drafting a strategic program for the introduction of sustainable production systems for food, agriculture, forestry and organic products.

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