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# Green Patents as an Opportunity to Commercialize Innovations Supporting Sustainable Development

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## Summary

Climate change and sustainable development are the most current topics when companies try to plan their strategies. New technologies are the tools that can help to solve various problems. To commercialize new technologies one of the most important topics is intellectual property protection. In case of green technologies, the good form of protection are green patents. The author argues that green patents are an opportunity to commercialize innovations supporting sustainable development.

The aim of this article is to identify current trends in the creation of environmental technologies (“green technologies”) and to identify areas where the newest technologies supporting sustainable development are created. This goal will be achieved by analyzing “green patents”.

Research methods included descriptive, comparative, and expository analysis. These methods were used to better understand the areas where “green innovations” are being created. To identify the current trends, a desk research

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method was used. As part of the research, literature, documents, and statistical data were analyzed as well as a case study of the “WIPO Green” technology platform supporting the transfer of green technologies to implement sustainable development was presented.

The research shows that in many areas related to the implementation of sustainable development goals, a number of patents protecting green technologies is increasing. However, protecting new solutions in the form of patents does not solve the problem. The solution is their commercialization, which opens up opportunities for achieving sustainable development goals.

**Keywords:** green technologies, green patents, sustainable development, commercialization

## Zielone patenty jako szansa na komercjalizację innowacji wspierających zrównoważony rozwój

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### Streszczenie

Zmiany klimatyczne i zrównoważony rozwój to obecnie jeden z kluczowych tematów zarówno dla decydentów jak i przedsiębiorstw. Narzędziami, które mogą pomóc w rozwiązaniu wielu problemów współczesnego świata są nowe technologie. Jednym z najważniejszych obszarów w procesie komercjalizacji nowych technologii jest ochrona własności intelektualnej. W przypadku zielonych technologii dobrą formą ochrony są zielone patenty. Autorka stawia tezę, że zielone patenty stanowią szansę na komercjalizację innowacji wspierających zrównoważony rozwój. Celem artykułu jest identyfikacja aktualnych trendów w tworzeniu technologii środowiskowych („zielonych technologii”) oraz identyfikacja obszarów, w których powstaje najwięcej nowych technologii wspierających zrównoważony rozwój.

Zastosowano zintegrowane podejście badawcze, łączące metody analizy deskryptywnej, komparatywnej i opisowej. Metody takie zastosowano, aby zidentyfikować obszary, w których powstają „zielone innowacje”. Dodatkowo, aby uzyskać kompleksowy obraz aktualnych trendów, wykorzystano metodę *desk*

*research.* W ramach badań dokonano analizy literatury, dokumentów i danych statystycznych oraz zaprezentowano studium przypadku platformy technologicznej „WIPO Green” wspierającej transfer zielonych technologii na rzecz wdrażania zrównoważonego rozwoju.

Z przeprowadzonych badań wynika, że w wielu obszarach związanych z realizacją celów zrównoważonego rozwoju liczba patentów chroniących zielone technologie wzrasta. Ochrona nowych rozwiązań w postaci patentów nie rozwiązuje jednak problemu. Rozwiązaniem jest ich komercjalizacja, która otwiera możliwości dla realizacji celów zrównoważonego rozwoju.

**Słowa kluczowe:** zielone technologie, zielone patenty, zrównoważony rozwój, komercjalizacja

## Introduction

Today’s world has enormous amounts of technology that enrich our lives. Unfortunately, in many cases, technological progress disturbs the balance of our planet. In recent years, unfavorable climatic phenomena have increased. People face air and water pollution, floods, droughts and fires, tornadoes, and others. They are the result of industrialization and are the result of human activity.

However, more people feel the need to take care of the environment. Fearing the loss of our planet, several initiatives of a systemic nature are being undertaken to prevent environmental degradation and ensure sustainable development [Heshmati, Tsionas, 2023; Hansa et al., 2023]. The actions are undertaken both locally and regionally. New technologies and innovations repeatedly bring solutions to environmental problems.

To be created, new technologies require long-term research and development (R&D) work as well as financing. The purpose of their creation is to solve a problem or meet a need. To serve people, the final effect of the innovation process should be their commercialization. However, before they appear on the market, they should be protected to avoid copying them by others mainly interested in the profits derived from them.

In the case of technological solutions suitable for industrial use, patents are a good form of intellectual property protection. They can secure a new technical solution for up to 20 years and facilitate the commercialization of a new technology.

In recent years, with growing problems related to environmental protection and the pursuit of sustainable development by economies, there has been a tendency to increase a number of patents in this area. Such patents are called “green patents” and since 2013 they have been subject to a detailed analysis by the World Intellectual Property Organization (WIPO).

The author argues that green patents are an opportunity to commercialize innovations supporting sustainable development. The aim of this article is to identify the current trends in the creation of environmental technologies (“green technologies”) and to identify areas where the newest technologies supporting sustainable development are created. This goal will be achieved by analyzing “green patents”.

Research methods included descriptive, comparative, and expository analysis. These methods were used to better understand the areas where “green innovations” are being created. To identify the current trends, a desk research method was used. As part of the research, literature, documents, statistical data were analyzed, and a case study of the “WIPO Green” technology platform supporting the transfer of green technologies to implement sustainable development was presented.

The article contributes to the discussion on the role of green patents in achieving the sustainable development goals, encouraging reflection on the directions of development of new technologies. It emphasizes the need to protect “green technologies”, which may be crucial in the process of their commercialization.

## Green technologies as a source of innovations

Global environmental issues have become a global challenge. Over recent years we can observe a tremendous amount of research, innovation and new technologies deployed to address the challenge of the climate change. The companies worldwide are obliged by environmental policies force, growing competitive pressure and technological capabilities to focus on improvements in their environmental performance [Semenova et al., 2023]. The fact is that the world now has access to 80 percent of the technologies needed to halve global greenhouse emissions by 2030. The estimates show that in the nearest future we will see many more game-changing solutions [WIPO, 2023].

The problem of the need to prevent the negative effects of economic growth and development, the main cause of which were previously recognized criteria for running a business (increased production, its rapid renewability, increase in profits), leads to the conclusion that the balance in the ecosphere can be restored by innovations. For this to happen, the approach to creating innovations must change radically. Modernizing innovative activities should consist in subordinating them to the criteria of sustainable development. Therefore, the criterion of harmlessness to the natural environment should be introduced into the definition of innovation. It can be stated that no new product, process, management system or marketing tool should be considered an innovation if, during their implementation, natural resources of the natural environment are reduced, or the quality of their components is reduced [Białoń, 2012: 197]. The desire to create new knowledge

and innovative solutions create new development opportunities for the companies. Modern enterprises strive for sustainable development. This situation means that entities in their activities must consider both aspects of innovation and ecology [Marczewska, 2016: 19]

Currently, there is an increasing connection between sustainable development issues and economics and the environment [Nitta, 2005; Jovanovic et. al., 2022]. They are of interest not only to business, but also to political circles and society as well as universities and research institutes [Salvamani et al., 2020]. There is also a significant increase in consumer awareness of environmental pollution and its consequences. Moreover, new technologies are more efficient and contribute to reducing global poverty.

Due to the global nature of the challenges related to climate change and poverty, there is a need to ensure the widest possible dissemination of appropriate technologies in countries with various levels of development. This applies to both developed and developing countries, which could reduce the negative effects of environmental pollution, or cause less environmental pollution compared to alternative solutions [COM, 2002: 2]. Such technologies are called green technologies or environmental technologies and are referred to in the literature as technological solutions that perform many crucial functions [Marczewska, 2016: 21; Chakrabarti, 2014: 3–4; Waszak, 2015]:

- support the protection of the natural environment;
- in practice, they cause less environmental pollution;
- use all available resources in a more sustainable way;
- they recycle their waste and unnecessary products;
- process residual waste in a more ecological way than alternative substitutes.

According to the OECD, green technologies are environmentally sound technologies that *“protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual waste in a more acceptable manner than the technologies for which they were substitutes”* [United Nations, 1992]. Green, environmental, and eco-technologies or innovations are used as synonymous terms according to some authors [Fayot et al., 2023].

Well-designed environmental technologies can be described by the following characteristics: they are created and operate in accordance with the principle of sustainable development, they meet the needs of society without compromising the ability of future generations to meet their own needs, and they do not contribute to the depletion of natural resources [Chakrabarti, 2014: 3]. In the case of products that result from the use of this type of technology, they should be designed in such a way that they can be fully regenerated or reused. Green technologies reduce waste and pollution by changing production and consumption patterns. They are an alternative to technologies that negatively impact health and the natural world.

They contribute to creating a center of economic activity around technologies and products that bring benefits to the environment, accelerate their implementation and diffusion, and influence the creation of new jobs [Chakrabarti, 2014: 4].

The following elements influence the development of green technologies: knowledge, experience, products, services, equipment, procedures, as well as organizational and management systems. It may prove that technologies which are environmentally friendly in a specific time and geographical conditions will be replaced in the future by other, more ecological solutions.

Environmental technologies are remarkably diverse. They differ not only in the process of creation, but also in their maturity (some have already been commercialized, others are in the development phase), as well as the scope of application. Some authors identify common features, distinguishing them from other types of technologies and comparing these two groups according to the following criteria [Marczewska, 2016: 28–26; Desheng, Jiakui, Ning, 2021; Juma, 1994]:

- the main factors of creation – in the case of environmental technologies, these are: regulations, multilateral agreements on environmental issues; while for other technologies it may be market forces (e.g., demand, competition, production bottleneck, etc.);
- sources of financing – in the case of environmental technologies, public financing is significant, other technologies are largely financed from private funds, including reinvestment of profits, the use of risk capital and the sale of shares;
- location of R&D activities – environmental technologies are mainly developed at universities, public institutions, and research laboratories, while other technologies may also be created in enterprises;
- technology transfer mechanisms – in the case of environmental technologies, we are dealing with a transfer to the private sector, the importance of partnerships is growing public-private (science-business cooperation); while in the case of other technologies, there are forms of transfer between enterprises and partnerships between enterprises and research institutes;
- commercialization – in the case of environmental technologies, small and medium-sized enterprises are increasingly involved in their commercialization, sometimes external incentives and support are needed; for other technologies, commercialization takes place mainly within the enterprise;
- applications – only some environmental technologies can be used on a large scale, so the location of their application is mainly determined; other technological solutions are increasingly expanding their scale even to the global scope;
- methods of transfer to developing countries and countries undergoing economic transformation – in the case of environmental technologies,

such transfer takes place through enterprises, sometimes with financial support from various sources; in other technologies, the transfer takes place through the companies' own channels.

Green technologies include diverse solutions and can be used in many sectors, e.g.: pollution control, waste management, recycling, waste minimization, clean technologies, measurement and control, clean products. The analysis of green technologies allows us to distinguish three functional categories [Juma, 1994: 141]. The first one includes processes and materials developed to reduce or eliminate the negative effects on nature of the activities undertaken so far, excluding a need to introduce fundamental changes to the existing process. The second category of green technologies refers to the modification of the production process, including the use of new monitoring and control techniques or changes to the raw materials and materials used. They can be incorporated into already existing technologies to eliminate or reduce their negative impact on the environment. The third category is related to the development of new technologies that have a smaller negative impact on the environment than previously used alternative solutions.

The issue of green technologies and their management is becoming an increasingly important topic discussed on an international scale. Among many related issues, much attention is paid to the analysis of enterprise strategies aimed at developing nature-friendly innovations. Green technologies provide the basis for creating this type of innovation, which is commonly referred to as eco-innovation, green innovation, or environmental innovation.

## Green patents

*“A green patent is a patent on products or designs that provide environmental benefit. The term green patent represents one use of the term green, which refers to items or phenomena that accommodate decreased energy consumption or otherwise benefit the environment”* [Techopedia, 2024]. Green patents can be broadly defined as technologies or applications that mitigate or adapt to the climate change. They are identified through the specific code Y02 assigned by the European Patent Office – EPO [Lavopa, Menendez, 2023]. The eco-innovation intensity of companies may be measured by green patents as a parameter. Some authors underline their positive impact on the financial performance of the companies [Jovanović, Krstić, Berezjev, 2022].

Looking at the green patent filings globally, one can say that they have a positive impact on economic activity, especially in the medium term, which is not statistically distinguishable from that of nongreen patent filings. Green patents have an impact on higher investments but they do not enhance aggregate TFP over the horizon considered. For the companies green patents may boost revenue – but



not as much as nongreen patents. It depends on production systems' continued reliance mostly on nongreen technologies. The green transition seems to be at least as promising as the ICT revolution [Hasna et al., 2023].

Evidence shows that green patents are important for green innovation development. Green patents may be the source of technology diffusion. They constitute a significant percentage of the world's green innovations. However, the countries that rank high as important markets for new technologies do not necessarily rank high in terms of the development of such technologies. For example, 15.4 % of the world's environmentally related innovations were patented in Europe and 28% of world's environmentally related innovations were developed in Europe. 25.1% of the world's environmentally related innovations were patented in the United States and 21.1 % of world's environmentally related innovations were developed in the United States. Opposite 37.7% of the world's environmentally related innovations were patented in China and 3% of world's environmentally related innovations were developed in China [OECD, 2024].

According to the UNIDO new technologies have been steadily growing since 2000 to accelerate the transition to net zero. The main source of green innovation is a manufacturing sector. Industrial firms submit six out of every ten global patent applications for technologies that can be used to help the climate change. What is interesting, 85% of green patents are held by industrial firms from just five countries: Japan, China, the USA, Germany, and the Republic of Korea. Green technologies have the potential to revolutionize and affect most aspects of our lives – especially those associated with renewable energies [Lavopa, Menendez, 2023: 3].

The biggest problem because of its high contribution to global greenhouse gas emissions is the industry. It has always been perceived as one of the major sources of the problem. Now, according to some authors, it is increasingly becoming part of the solution [Lavopa, Menendez, 2023: 6]. Patent system plays an important role in connecting economic growth and environmental degradation. That is why it should play a significant role in ensuring that future development is sustainable [Nitta, 2005].

Different organizations recognize green patents as an important source of information about sustainable green innovations development. Measurement of green innovation includes three main indicators: R&D expenditure (input), number of green patents (output), green total factor productivity (performance). Such indicators reflect the technology innovation achievement performed by the companies in comparison to the other indicators [Desheng et al., 2021].

Some authors also suggest that filing patents has big importance for green energy development. Protection of patents can play an important business role and what is crucial, they may drive a company's growth, no matter it is a small or big size one. Patent applications and granted patents are assets. They can enable more effective collaboration and unlock preferential tax breaks, they can be valued in the accounts but also influence investors [Brown, Belcher, 2023].



International organizations such as the World Intellectual Property Organization (WIPO), Organization for Economic Co-operation and Development (OECD) and the European Patent Office (EPO) have focused many of their studies on the role of patents in the development and dissemination of sustainable technologies, using patent databases. To identify green patents scientists can use three types of methodologies. They are based on the code classification: ENV-Tech (developed by OECD), IPC Green Inventory (WIPO) and Y02/Y04S Tagging Scheme (EPO) [Fayot et.al, 2023].

Enterprises that are interested in introducing green innovations to the market often look for green patents. According to the International Monetary Fund we can divide green patent filings into eight categories: 1. adaptation to climate change; 2. buildings; 3. carbon capture and storage of greenhouse gases; 4. ICT aimed at the reduction of energy use; 5. production, distribution, and transport of energy; 6. industry and agriculture; 7. transportation; and 8. waste management and wastewater [Hasna et al., 2023].

Green patents may be divided into six categories: energy, transportation, water adoption, buildings, environmental management and capture, storage, and sequestration of GHG emissions [Ghodsi, Mousavi, 2024]. According to the results of the research by of Ghodsi and Mousavi energy generation and transportation, out of six defined categories, lead with 36% and 34% of global green patents. Countries in advanced economies are viewed as drivers of innovation. In the eyes of many they are leaving developing nations far behind. This gap worsens climate risks and inequalities.

A good and easy to access source of information about green patents and their classification is IPC Green Inventory created by WIPO [Bretas et al., 2019]. It facilitates searches for patent information relating to the Environmentally Sound Technologies (ESTs), ESTs are currently scattered widely across the IPC in numerous technical fields (Table 1). The Inventory attempts to collect them in one place [WIPO, 2024].

**Table 1.** IPC Green Inventory topics

General topic	Detailed topics
1	2
Alternative energy production	Biofuels, fuel cells, hydro energy, wind energy, geothermal energy, harnessing energy from human-caused waste, solar energy, other production, or use of heat, not derived from combustion, e.g., natural heat, using waste.
Transportation	Vehicles in general, rail vehicles, vehicles other than rail vehicles, marine vessel propulsion, cosmonautic vehicles using solar energy.
Energy conservation	Storage of electrical energy, power supply circuitry, thermal building installation in general, low energy lighting, recovering mechanical energy.

**Table 1** (cont.)

1	2
Waste management	Treatment of waste, reuse of waste materials, pollution control.
Agriculture / forestry	Forestry techniques, alternative irrigation techniques, pesticide alternatives, soil improvement
Administrative, regulatory or design aspects	Commuting, e.g., telework, etc., carbon/emissions trading, e.g., pollution credits, static structure design.
Nuclear power generation	Nuclear engineering, gas turbine plants using heat source of nuclear origin

Source: based on IP Green Inventory database analysis, <https://www.wipo.int/classifications/ipc/green-inventory/home> (accessed: 20.01.2024).

Analyzing data from an investor point of view, Global Data identified and mapped relevant patents to the environmental themes (Table 2). Identified patents can help in decreasing emissions, decreasing energy consumption, and providing other environmental benefits. In 2022 patent data showed: 57,367 assignees, 199,542 inventions, 2,078,117 patent filings, 1,262,790 grants. The data shows that we can observe an increase in a number of patents in some vital environmental themes like climate change, carbon emissions, renewable energy, sustainable transportation, solar, food and agri-tech, biodiversity, sustainable farming, electric vehicles, circular economy are discussed [Global Data, 2024]. Climate Change is one of the environment-related themes with 3,366,795 patents, highest among all themes.

**Table 2.** Environmental themes and number of patents in 2018–2022

Environmental theme	Number of patents
Climate change	3,366,795
Carbon emission	1,855,352
Renewable energy	796,288
Sustainable transportation	477,661
Solar	404,523
Food and Agri Tech	331,161
Biodiversity	283,114
Sustainable Farming	278,105
Electric vehicles	187,358
Circular economy	86,153

Source: based on Global Data, <https://www.globaldata.com/esg/environment/patents/signals/> (accessed: 10.01.2024).

We can also observe an increase in a number of green patents by sector (Table 3). Some sectors are more active in creating green technologies than others. For example, an automotive sector is the key innovator in the green patent landscape in years 2020–2022 with the 179,992 of patents. The next are technology, media, and telecom; chemicals; industrial goods & machinery; agriculture & forestry. However, one can see that a number of patents in some sectors decreased in 2022. It may be a result of the pandemic and lockdown in previous years. Generally, the increase in green patent filings is visible.

**Table 3.** Green patents by sectors (2020–2022)

Sector	Number of patents 2020	Number of patents 2021	Number of patents 2022
Automotive	61, 686	71, 035	43, 839
Technology, Media, Telecom	18, 073	27, 068	29, 206
Chemicals	8, 582	9, 215	5, 814
Industrial Goods & Machinery	7, 021	8, 819	6, 865
Agriculture & Forestry	7, 511	7, 292	2, 909

Source: based on Global Data, <https://www.globaldata.com/esg/environment/patents/signals/> (accessed: 10.01.2024).

## Importance of technology transfer in green patents

To commercialize green technologies sometimes companies need to transfer them from research institutes, universities, or other companies. Finding the partner and networking is not an easy task. An example of practical activities in the implementation of sustainable development goals and activities for the transfer of green technologies is the technological platform developed and implemented by WIPO called “WIPO Green” [WIPO GREE, 2024].

WIPO GREEN is a type of public-private partnership established in 2013 by the World Intellectual Property Organization [Lisowska-Bilińska, 2020]. It is an online platform that supports all activities aimed at accelerating progress in the field of green innovations and the development of new environmentally friendly technologies and their dissemination in societies on a global scale [WIPO Green platform, 2024]. Through its databases, cooperation networks and numerous networking events brings together inventors of “green” innovations and those who are looking for such “green” solutions to a specific problem. For example, it may be a sustainable access to water or environmentally friendly management of the sanitary system.

WIPO leverages its intellectual property expertise to focus on three global issues: climate change, public health, and food security. Access to the platform is free for

anyone who registers in the system as a WIPO GREEN user. It is financed from the regular budget of WIPO, although financial support for specific projects is provided by both national governments and associations related to intellectual property. WIPO member states can also support this initiative at both national and regional levels and finance individual projects developed within it by entrusting their deposit funds.

The platform is a unique idea because it collects technologies at all levels of development in one place, from prototypes to fully attractive market products. These technologies are available as licenses, collaborations, joint ventures, or for sale. The WIPO GREEN database already contains over 3,000 technologies and reported demands from entities looking for “green” solutions [Lisowska-Bilińska, 2020]. It is divided into seven categories: buildings and structures, products, materials and processes, energy, agriculture and forestry, pollution and waste, transport, and water. Registered users only need to describe the benefits their technology can bring to the environment. In 2022 the platform was used by almost 2,500 users from all over the world; there were 128 000+ listed technologies, needs and experts; 150 partners; 1000+ connections were made via their databases, events, and projects. These include small and medium-sized enterprises, universities, research institutes and international companies. All technologies available on the WIPO GREEN platform remain the property of the entitled person, and interested parties negotiate the terms of cooperation themselves.

Climate change and food security are one of WIPO GREEN’s three strategic goals as well as climate-smart agriculture, which aims to improve the resilience of crops and reduce their vulnerability to climate change, increase productivity and reduce greenhouse gas emissions. For example, in 2019, WIPO GREEN in South America launched a project to explore the feasibility of using innovative climate change-adapted solutions for wine production in Chile, as well as for land cultivation and management in Argentina and Brazil. Innovations at the regional level since 2015, WIPO GREEN has been organizing numerous projects at the regional level to accelerate the development of innovations and the dissemination of “green” technologies within individual sectors. Already underway are wastewater treatment projects in Indonesia, the Philippines and Vietnam, a project improving agriculture and water management in Ethiopia, Kenya and Tanzania, water resources management in Switzerland, and a project on energy resources, clean air, water and agriculture in Cambodia, Indonesia, and the Philippines.

Mutually beneficial partnerships have also been established because of international projects. For example, in 2018, thanks to the project launched in Southeast Asia as part of WIPO GREEN, the “Green School” in Bali, Indonesia, established cooperation with the American company Zero Mass Water. As a result of this cooperation, the entire school campus in Bali gained an opportunity to use source hydro panels provided by an American company for a constant supply of

drinking water. The school in Bali already operates entirely based on the principles of sustainable development, also using other “green” technologies, e.g., those based on renewable energy, which cover up to 85 percent of the school’s energy needs, an ecological water filtration system, a composting station, aquaponics, or buses powered by biofuel. As the director of the “Green School” Innovation Center in Bali emphasizes, finding the right partner for cooperation is not always an easy task. When making decisions regarding the implementation of a new technology, many factors must be considered, such as the area in which we work, or the geographical and climatic factors of our workplace. Such a cooperation between technology providers and potential customers can take place not only through the above-mentioned innovation development projects, but also through the WIPO GREEN databases, through which registered users from the most distant countries can contact each other directly and initiate a partnership that will enable them to find solutions to specific challenges related to climate change. The WIPO GREEN initiative is constantly improving its tools and database functionalities to better serve its users in searching for both the most effective, environmentally friendly technologies that are worth implementing for the benefit of the environment and humans.

The rise in a number of green patents doesn’t mean there will be more green innovations. Only commercialization of protected technologies may bring new solutions to the market and help to meet sustainable development goals. Commercialization is a complex process that is not always easy, especially for small and medium companies. It requires specific knowledge and resources. Technology transfer is very important for those who lack it. Even if the company faces the market opportunity by owning a green patent it may not succeed but a green patent can open new possibilities. That is why it can create the opportunity for sustainable development.

## Conclusions

The commercialization of green technologies is important in achieving the sustainable development goals. In recent years, there has been a clear upward trend in submitting applications for green patents to patent offices. However, it is still the domain of highly developed countries. For the poorest and most needy countries to benefit from the commercialization of green technologies, it is important to undertake initiatives enabling technology transfer. This is not an easy task. Enterprises operate for profit, and green patents are intended to provide them with financial benefits. The poorest countries do not have money to buy expensive advanced technologies. Therefore, the discussion and development of methods for the transfer of green technologies to achieve the sustainable development goals are extremely important and should constitute an inspiration to undertake new directions of scientific research.

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