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International Strategies for Protecting Green Technology: The Case of Pakistan

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Abstract

While world is trying its best to combat climate change and support the green economy paradigm, proper legal shield to green technology is imperative. This paper undertakes a new study that reviews international actions to safeguard green technology and how they pertain to the legal structure of developing countries particularly Pakistan. Drawing from research published up to year 2024, this research considers the most important global legal frameworks, IPR structures, and technology dissemination procedures that are necessary for protection of green technologies. It also provides a comprehensive look at how Pakistan currently treats the issue from a legal perspective, where there is a focus on the difficulties currently facing this field and the new legal approaches that will enhance the development of green technology. The study emphasizes on increasing the capacity of such countries as Pakistan to be active participants in the global sustainability processes. These findings provide useful recommendations for policymakers, legal scholars, and international organizations, providing lessons learnt from current positive developments in environmental law and technology.

Keywords International Strategies, Green Technology Protection, Intellectual Property Rights (IPR), Climate Change

Introduction

Background on Green Technology

Green technology is the technology that is environment-friendly, also known as the clean technology or environmental technology which involves all the practices, processes and innovations that are developed with an intention to create the lesser or negligible impact towards environment and nature. In its basic sense, it is mainly used to prevent pollution, assist with protection of resources, and manage the effects of climate change. Green technology is basically an umbrella term that involves several fields such as renewable energy technology, environment friendly agricultural technology, water treatment technology, waste treatment technology and energy efficient technologies. UNEP states that green technology is crucial in sustainable development since it creates and sustains income subsequently developing economies besides checking pollution of the environment as well as economic and social inequality (UNEP, 2019).

The importance of green technology in world sustainability is immensely highlighted through its importance in tackling with present day global environmental problems. Due to climate change impacts in environmental degradation and effects on social wellbeing, green technology innovations form part of the integral environmental policy measures. The Intergovernmental Panel on Climate Change (IPCC) has always stressed the fact that drastic cuts in greenhouse gas emissions cannot be achieved without greater utilization of green technologies (IPCC, 2021). These technologies are considered as important enablers in the realization of the long-term goal of the Paris Agreement that

targets to maintain global warming to below 2°C above pre-industrial level. In addition, green technology plays an essential role in the realization of most of the United Nations Sustainable Development Goals as outlined by the Sustainable Development Goals list; specifically, SDG 7 on affordable and clean energy, and SDG 13 on climate action (United Nations, 2015).

Patents are important for green technology security and its development, especially when it comes to promoting initiatives to protect innovation and support long-term technology development. They grant inventors' monopoly over those inventions and thus encourage innovators to undertake the costly process of R&D and allowing companies to capture the benefits of their innovations. WIPO notes that IP is extremely relevant to technology advancement to the extent that it offers protection of innovations by supplying the legal building blocks for inventors to reap gains on their investment decisions (WIPO, 2020).

However, the need to protect green technology goes beyond incentives for companies to invest in the technology. It is also about making certain that such technologies are available and can be implemented at areas require them. The law regulating IP rights at the international level is provided under the TRIPS agreement which outlines the minimum standards that member states of the WTO have to provide for protection of IP rights (WTO, 1994). Even though the TRIPS has a strong IP protection agenda, provisions have made for flexibilities including the country's ability to override patent rights under certain circumstances, such as in the case of public health threats or environmental degradation (Article 31, TRIPS). This freedom is quite essential especially where the global public may require more open and expanded ownership of technology to fight climate change and environmental depletion (Correa, 2000).

Furthermore, green technology requires protection for inventions, as it also requires that technology is transferred fairly across the globe, and especially to the developing world. Technology transfer is an important component in the UNFCCC's Technology Mechanism, which aims to improve climate change technology development and deployment to developing countries (UNFCCC, 2015). This mechanism appreciates the fact that as much as IP rights are central, they have to be aligned with need to ensure that the developing nations receive the necessary technologies that they require to deal with their environmental and developmental imperatives (UNFCCC, 2015). Thus, it is crucial to keep the two objectives in mind when designing international protection strategies for green technologies: on the one hand, the protection of intellectual property rights sufficient to encourage invention; on the other hand, the protection of dissemination of these technologies to ensure sustainability across the globe.

Significance of the Study

This study holds a great importance as the field of green technology in Pakistan is still underdeveloped and there is a requirement of sustainable development as well as environmental protection in the country. By analyzing such international approaches to protection of green technologies and their applicability to the Pakistani context, this research will help to identify how the country could build up the sector for green technologies. The implications of the study will be useful to existing and potential key policy makers, economic players around the globe and international organizations in the process of formulation of proper policies aimed at enhancing inventions and innovativeness, protection of intellectual property rights and enhancement of cross country collaborations. In addition, it will help advancing Pakistan's ability to address international climate commitments with the potential for economic development through innovations in green technology.

Literature Review

Ahmed and Zafar (2023) highlight only the enforcement problems in the IPR in Pakistan pointing towards green technology. They further explain that enhancing the enforcement measures and strengthening judicial systems to uphold the green technologies are vital to enhance the green innovations. They stress that due to poor enforcement, the generation of indigenous green technologies is unlikely to occur.

Siddiqui and Rehman (2021) examine how Pakistan's technological cooperation with developed countries in the technological protection and development of green technology is possible. According to them, one can opt for collaborative projects or ventures or the creation of research partnerships as means of knowledge transfer. They also observe that Pakistan does not offer adequate policy encouragement for international association, which restrains the introduction of the green technologies into the country.

Khan and Mahmood (2022) analyse how the Paris agreement and the Trade Related Aspects of Intellectual Property Rights (TRIPS) has boosted green technologies in Pakistan. They also bring attention to Pakistan's delay in adopting these global frameworks owing to institutional and policy constraints. According to their study, these international strategies could enhance proactively the Pakistan green technology transfer and innovation and also, provide much stronger legal safeguards to green technologies.

Hussain (2020) elaborates that establishing and effective national policy that complies with the global green technology protection norms and standards is required He opines that while the global strategic directions are relevant, Pakistan needs more specific national strategic directions that are appropriate to its context. In Hussain's opinion, there should be a rise in research and development (R&D) coupled with enhanced domestic institutions to support international initiatives in protecting green technologies.

Malik and Baloch (2019) merely take a structural perspective on why Pakistan has been unable to implement the protection of green technology in accordance to the international standards. The major challenges highlighted include lack of governmental support as well as inadequate capacities of the retirement institutions and more significantly lack of sufficient resources dedicated to the task. According to their studies, Pakistan has to accelerate infrastructure creation and policy changes emphasizing on the green technology criteria and utilization of foreign IP protection system.

Nawaz and Shah (2018) focus on the evaluation of the economic effect of implementing the international strategies for protection of green technologies in the Pakistan. Some of them have contended that by packing with international IPR system, FDI can be encouraged into Pakistan's green technology initiatives. Thus, the research realizes that enhanced legal rights could prompt the MNCs to transfer technologies and fund green ventures in Pakistan.

Ali and Javed (2017) examine the positions and contributions of WIPO and WTO to the protection of green technology in Pakistan. They argue that such organisations can provide technical cooperation as well as capacity building programmes, since Pakistan requires aid to develop its national IP system. Their studies revealed that cooperation from countries from all over the world is highly crucial in the protection of green technology.

Rizvi et al (2016) explore the effect of limited legal protection for innovation on green technology in Pakistan. They asserted that weak IPR structures deter local and international investors from investing in this country's green technologies. Rizvi and Ahmad suggest the intellectual property law in Pakistan should be in line with the other countries; the author considered it important for attracting green technology patents and innovations.

Farooq and Iqbal (2015) have mainly concentrated on the policy environment on green technology and protection of environment in Pakistan. They find that the relative lack of protection afforded to green technologies by Pakistan's environment regulatory institutions does not only limit the protection of such technology, but also the adoption of cleaner industrial practices as well. According to their research, the participation of international environmental policies in national frameworks can improve the green technology and environmental issues.

Aslam and Saeed (2014) examined the ability of PPP in the international protection of green technologies. They argued that through such collaborations it becomes possible for the country of Pakistan to upgrade to better green technologies and get to par with other countries. But they stressed that the existing institutional environment of Pakistan's PPP has not envisaged the necessary support to make these partnership successful in relation to green technology development and protection.

Focus on Pakistan

Focusing on the country like Pakistan, as a developing country, with the growing population and environmentally sensitive issues it offers the interesting context for the evaluation of green technology protection and further development. The country's energy industry is mainly based on fossil fuels resulting into high carbon emitters and destruction of the environment (Pakistan Ministry of Climate Change, 2021). However, it also has rich renewable resources including solar, wind and hydroelectric power which has not actually been explored thoroughly yet (Khan & Rehman, 2020).There are indication of governments' commitment to increasing the share of renewable energy in the energy mix through policies which includes, but not limited to the Alternative and Renewable Energy Policy 2019 where the government of Pakistan seeks to have 30 percent of renewable energy in the total energy mix by 2030 (Government of Pakistan, 2019).

Despite these policy initiatives, Pakistan has a number of problems with the growth and support of green technology even if this country has made some policy measures in this respect. Some of the challenges include piracy and inadequate legal protection of IPs, inadequate technological resources, and weak funding for green technology projects (Raza et al., 2020). Moreover, Pakistan is a member of numerous global environmental conventions such as the Paris Agreement but the nation has inadequate capacity to fulfil most of its obligations because of the limited economic resources and institutional development (Ahmad & Iqbal, 2021). These challenges make Pakistan as good case to study how other country strategies implemented for green technology protection can be best suited and managed in a development country environment.

The first reason for selection of Pakistan as case study is that it presents a case of a developing country with severs environmental problems and future prospects for GREEN technology that has to work within the framework of multilateral IIP laws and technology transfer. This analysis is especially useful in the understanding of the challenges presented by the IP exploiting of the environment through the application of policy and law affecting sustainable development. The paper is of great importance to the policymakers, legal scholars, and practitioners in the areas of IP law and environmental conservation.

Therefore, the aim of this article is to identify international approaches to the protection of green technology with particular reference to Pakistan. This article analyses Pakistan's legislation and standards, the agreement participation and existing domestic issues in order to determine the best practices and potential recommendations for the protection and development of green technology in Pakistan. It will add to this discourse on how developing countries can use international law to promote their sustainable development agendas without leaving green technology vulnerable nor too proprietary.

Overview of Green Technology Development in Pakistan

Pakistan's green technology sector has significantly developed mainly in the solar, wind, and bioenergy fields. The country has a lot of potential when it comes to renewable energy due to its geographical and climate characteristics, thus making it play a central role in the world's energy transition. Especially, solar energy has received much interest because of higher direct solar radiation in Pakistan ranges between 5.3-5.5 kWh/m²/day (Shaikh et al., 2019). This has promoted the establishment of big solar projects like the Quaid-e-Azam Solar Park which has a capacity of 1000MW, and it's one of the world's largest solar parks (Government of Punjab, 2021).

Wind energy also has enormous potential particularly in the coastal areas of Sindh and Balochistan provinces. These areas get relatively steady wind power and just the Gharo-Keti Bandar Wind Corridor is believed to have the capacity of 50,000MW (Alternative Energy Development Board, 2022). Many wind projects are in the pipeline adding to the portfolio of Pakistan's energy sector.

As highlighted earlier, Pakistan has a bioenergy development plan that is relatively less developed but it has a significant role in Pakistan's renewable energy strategy especially in the rural areas. The use of biomass in its main type of agricultural waste provides an opportunity to generate power in areas that are not endowed with commercial power sources (Khan & Saleem, 2023). This sector's development is backed by measures concerning the usage of waste as a source of energy, along with environmental and energy goals.

The government of Pakistan have adopted numerous measures and policies promoting the use of green technology. One of the legislative reforms can be highlighted as an important instrument, which is, the Alternative and Renewable Energy Policy 2019 (ARE Policy 2019) aims at achieving a target of 30% of renewable energy in the national grid by 2030 (Government of Pakistan, 2019). This policy contains a clear scheme of procuring incentives of investment in renewable energy sources based on such actions as tax exemptions and simplified procedures. Further, the NEPRA came up with regulations on net metering rules under which the consumer can participate where any excess energy generated from the renewable energy whether from a large or a small-scale solar project is fed back into the grid (NEPRA, 2021).

However, a significant increase in the deposit by the independent power producers conducting business in the power sector of Pakistan and having renewable energy portfolio depicts that the share of renewable energy in the total supply to the national grid is still low and it contributes nearly 6 percent as per the Pakistan Economic Survey 2023. Such a gradual integration brings out the fact that

policy incentives, technology adaptation and infrastructure development are still required for the meaningful exploitation of renewable energy resources in Pakistan.

Table 1: Current Renewable Energy Projects in Pakistan

Project Name	Energy Source	Location	Capacity (MW)	Status
Quaid-e-Azam Solar Park	Solar	Punjab	1,000	Operational
Gharo-Keti Bandar Wind Corridor	Wind	Sindh	50,000 (potential)	Under Development
Various Biomass Projects	Bioenergy	Rural Areas	200 (combined)	Operational/Planned

International Strategies for Protecting Green Technology

Intellectual Property Rights (IPR) Frameworks

Intellectual Property Rights (IPR) stand as the foundation for protecting innovations in green technology, to give the innovators and developers a chance to benefit from their inventions and innovations while at the same time promoting cross-boundary environment stewardship and sustainability. The concept of IPR globally is based on conventions and protocols that set the code of conduct as well as standard measures for the protection of intellectual assets across the countries. These frameworks are critical in order to prevent and mitigate the risks associated with the enforcement of intellectual property rights while at the same time addressing the rights and needs of the public especially in innovation technologies for climate change.

The Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement which is governed by the World Trade Organization (WTO) is one of the most crucial agreements in this regard. TRIPS sets up certain levels of protection of different types of intellectual property rights including patents which are of paramount importance to green technologies. According to TRIPS, patents confer exclusive rights on the owners for a limited period of time this being 20 years from the date of filing of the applications. Such exclusivity helps firms to recover their investments on research and development of green technologies and offers further encouragement for innovation (WTO, 2020).

Further, there is the Paris Convention for the Protection of Industrial Property through which industrial property rights such as those in patents, trademarks and industrial designs can be protected in each of the convention countries. The Paris Convention also adopts the idea of national treatment, which gives foreign inventors' inventions the same level of protection as those invented by domestic inventors in member countries. It also has a system of priority that entails the ability of an applicant to claim priority date in one member country for a subsequent application in other member countries within a certain period of time. This system is more advantageous to the green technology developers in that they can obtain patent protection in various territories at once (WIPO, 2019).

Another important treaty is the Patent Cooperation Treaty (PCT) that makes patent application international. PCT allows the inventors to file for an international application for a patent that could be used as a national patent in different member countries of the PCT. This is beneficial for the green technology firms which ply their business on the international market since the acquisition of patents in different countries is easier through this process (WIPO, 2021).

Technology Transfer Agreements

Technology transfer agreements play an important role for dissemination and protection of green technologies globally. Such undertakings make it easier to transfer technologies from the developed world to the developing world which is crucial in tackling environmental issues. Technology transfer can be defined as process through which technology information, skills, and technology rights are transferred from one entity to another as a means of using green technologies in diverse areas.

International mechanisms for technology transfer are typically woven into multilateral environmental agreements and international development paradigms. For instance, the United Nations Framework Convention on Climate Change (UNFCCC) has played a crucial role in advocacy of technology transfer as a way of facilitating adaptation of technology by developing nations to tackle climate change. The strategy of technology transfer is reinforced in the Paris Agreement, which calls on developed nations to facilitate the capacity of the developing nations to enhance their technologies through provision of financial as well as technical support (UNFCCC, 2021).

Technology transfer plays an intricate and complex part in safeguarding green technology. On one hand, it guarantees that green technologies developed are affordable to nations which may not have the capacity to independently develop such technologies. On the other hand the technology

transfer may involve value added activities, which means technology transfer has to negotiate in a way that safeguards the interest of the technology provider through a provision on technology rights. This dual role of technology transfer agreement is fundamental for the spread of green technology throughout the world to have access to such technologies while protecting the trademark at the same time (Maskus 2019).

The most commonly used technology transfer method is licensing, which means that the owner of a green technology patent authorizes another individual or company to use, produce, or sell the technology for a specific fee in form of royalties or other valuable consideration. These agreements are useful in ensuring that the technology is utilized in a manner that protects the inventor's IP yet at the same time providing access to environmentally beneficial technologies. In addition, technology transfer is promoted through the development and implementation of big green infrastructure projects through PPPs (UNCTAD, 2022).

International Cooperation and Collaboration

International cooperation and collaboration are crucial for the development of green technology because environmental problems are global in extent and need people's concerted efforts. International cooperation makes it easy for countries to share resource, information and best practice hence driving the adoption and deployment of green technologies. Partnership efforts that include cooperation in research and development projects are especially relevant in the sphere of green technologies since innovation is the solution to climate change and environmental pollution.

A good example of cooperation in the green technologies is the International Solar Alliance (ISA) which was initiated by India and France in 2015. The ISA is an association of states whose goal is to enhance the use of solar energy and decrease the cost of electricity from solar systems around the world. This way, member countries coordinate their efforts in research and development, as well as building of capacities and exchanging best practices in the deployment of solar technology. The ISA has played a major role in advancing technologies related to renewable energy consumption, especially solar energy in many developing nations, indicating how global cooperation counts in the advancement of green energy technologies (ISA, 2023).

Similarly, Clean Energy Ministerial (CEM) is another international organization which is a strategic group of energy ministers and it works to advance clean energy policy and initiatives. The CEM covers virtually all aspects of clean energy technologies which include but not limited to renewable energy, energy efficiency and smart grids. By coordinating the innovation of the outstanding local practices, sharing of projects, and standardization of practices essential for putting the green technologies at scale internationally, the CEM works to accelerate the rate of change (CEM, 2024).

Real life examples examined on effective international cooperation show that partnerships are critical to address the technical, financial and policy challenges that hinder the use of green technologies. For example, the Global Green Growth Institute (GGGI) has been involved in a number of projects, which focus on improvements of technologies and innovation for green growth and development with governments, companies, and multilateral organizations. These are necessary partnerships for the development of sustainability where GGGI aids in an extent in making green technologies available to all the countries especially those which are less endowed (GGGI, 2022).

Trade and Investment Policies

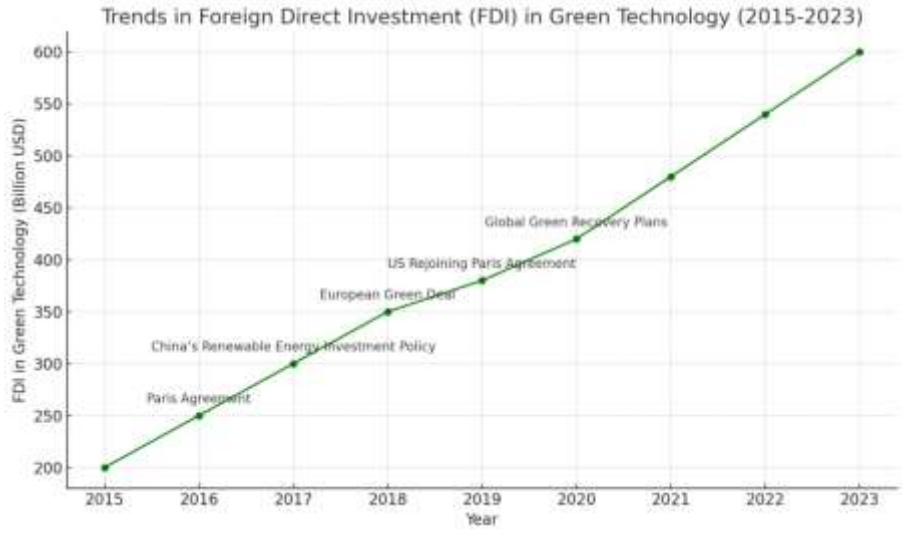
The polices relating to international trade and investment are important in the promotion and protection of green technology. Trade agreements shape the flow of green technologies across borders by providing liberalization of trade through tariff reduction or elimination, reduction in non-tariff barriers or their elimination altogether, and by creating favorable conditions for innovation. Likewise, investment policies are instrumental in providing the right incentive to attract the required investment for the creation and implementation of green technologies, especially in the growth markets.

The WTO has been the leading global institution towards efforts to liberalize trade in environmental products such as green technology. The current trade talks of the Environmental Goods Agreement (EGA) seek to progressively liberalize the trade in environmental goods for instance; renewable energy technologies and energy efficient products. This is usually because through making the production costs for these goods low, the EGA aims at increasing access to the products and promote transition to green economy (WTO, 2023).

While formulating investment policies, equal consideration should also be given to green technology development. To enhance the FDI in green technology sectors, the countries that have to adopt friendly investment policies like tax holidays, subsidies and bureaucracy free zone will get the green technology investment. For instance, the Chinese government has set advanced policies to encourage FDI in renewable power sector; therefore, the country has experienced rapid expansion in its solar and wind power sectors. These policies have supported China in becoming one of the world's leading producers of green technology (UNCTAD, 2023).

Furthermore, international investment agreements are not uncommon to have provisions for the protection of investors' IPR, which is important in advancing investment on green technology development. As the IIAs offer legal guarantees against risk of expropriation, these investments should become more attractive for investors from abroad, thus advancing since, the investments in green technologies. This in return helps export green technologies across the world and enable realization of international environmental targets (Sauvant, 2020).

Graph 1: Trends in Foreign Direct Investment (FDI) in Green Technology (2015-2023)



Case Study: Pakistan's Approach to Protecting Green Technology

National Intellectual Property Strategies

Pakistan's stance in safeguarding green technology under its national IP strategies is as important and dynamic right now. The country's IP system is mainly regulated by the IPO-Pakistan which was recently enacted under the Intellectual Property Organization of Pakistan Act, 2012. This body is responsible as far as the administration of patents, trademark, and copyrights are concerned, and are vital to the protection of green technologies. However, the extent to which these laws can protect green technology is still a rather contentious issue.

Pakistan's primary legislative measure governing the patent protection is the Patents Ordinance of 2000. It offers a protection term of 20 years for patents, which is also in concordance with the WTO'S TRIPS agreement. However, Pakistan still struggles to enforce the rights of IPs, especially those regarding green technology. These measures of enforcement are always constrained by resource constraints, many stakeholders are unaware of their responsibilities, and the judicial systems in the respective countries are still developing. Thus, despite the possibilities to apply green technologies in achieving the goal of sustainable development, there are still some challenges with poor intellectual property rights protection and enforcement.

However, Pakistan's IP laws are not still prepared to address the needs of the Green technologies or products where innovations can be more complicated and ever-changing. Since there are no specific legal frameworks on green technology patents, inventors and companies experience challenges in getting and protecting patents hence; low incentives for innovative growth in this important area. These challenges are aggravated by the fact that most of the patent examiners and members of the judiciary do not possess sufficient technical skill in the field, which leads to ineffectual or contradictory protection of green technologies at times (Iqbal, 2022).

Technology Transfer and Innovation Ecosystem

Technology transfer mechanisms in Pakistan have significant impacts on the country's environment for innovation, especially about green technology. The process of technology transfer in Pakistan is regulated both by national legislative base and by a number of international treaties, but cooperation with the leading world practices is still under construction.

To ensure the appropriate implementation of technology transfer in Pakistan, the government has put in place the National Science, Technology and Innovation (STI) Policy. However, several factors have restrained the policy to have more significant effects to the development of green technology. Some of the barriers these include limited and out-dated infrastructure within the health institutions, low funding on R&D, and poor linkages between the public and the private sectors (Siddiqui, 2023).

Public sector is a driving force in innovation, and this can be evidenced through HEC and other government bodies for promoting research. These institutions are supposed to encourage the R&D activities and technology transfer but it has been observed that they are hampered with various bureaucratic issues and their interaction with private sector is minimal. On the other hand, concerning green technology the private sector in Pakistan is emerging slowly but it is still in its infancy. It really has become pertinent for governments and companies from the private sector to collaborate with a view of harnessing the potential of the two aspects in order to ensure that green technologies are developed and commercialized (Khan & Ali, 2021).

On the international level, another issue that needs improvement is the correspondence of Pakistan with global technology transfer systems. Despite the fact that Pakistan is a member to many international conventions and agreements regarding the transfer of technology like the Paris Convention and the TRIPS Agreement, problems persist over the implementation of these agreements. This has led to a technology transfer environment that is complex and sometimes does not offer appropriate stimuli to encourage the diffusion and adoption of green technologies (UNCTAD, 2023).

International Partnerships

Pakistan should develop research collaborations with countries across the globe to enhance the development of its green technology industry. Such partnerships help in the sharing of information and experience and the adoption of the best practices that are important in overcoming domestic barriers to the protection and development of green technologies.

Pakistan's role in international green technologies can also be ascertained through its membership to different global and regional treaties. For instance, Pakistan is a signee to the UNFCCC, and as such, has an assurance to the Paris Convention to lower the emission of greenhouse gases. Nevertheless, the implementation of these commitments has been challenging in terms of developing green technologies in Pakistan, especially since there is no clear and long-term vision and insufficient funds available for implementation (UNFCCC, 2023).

Among the international linkages in green technology projects, the most remarkable example is the Pakistan and China relationship in the CPEC program. The schemes covered by this cooperation relate to the initiatives increasing the potential of renewable energy sources in Pakistan including especially solar and wind energy. These partnerships have specifically the potential to span up Pakistan's green technology industry; nevertheless, these collaborations demand perplexing considerations in regards to sharing balanced technology and counteracting therewith, infringement on the rights of intellectual property in international affairs (Zhou & Arif, 2022).

Another example is, the World Bank and the Asian development bank which finance various green technology project in Pakistan. These projects are primarily conducted in the sectors regarding renewable energy and energy efficient resources with the prudent characteristics to waste management and climate change adaptation; they offer a chief support for Pakistan's green technology framework. Though, these projects rely on international support for sustainability, and efficient utilization of the technologies in use (World Bank, 2023).

Trade and Investment Environment

A broad analysis of the green technology growth and protection constraints reveals Pakistan's trade policies and investment environment. The primary purpose of the country's trade polices is for economic development, however, there is a growing awareness to include environmental consideration on the trade policies.

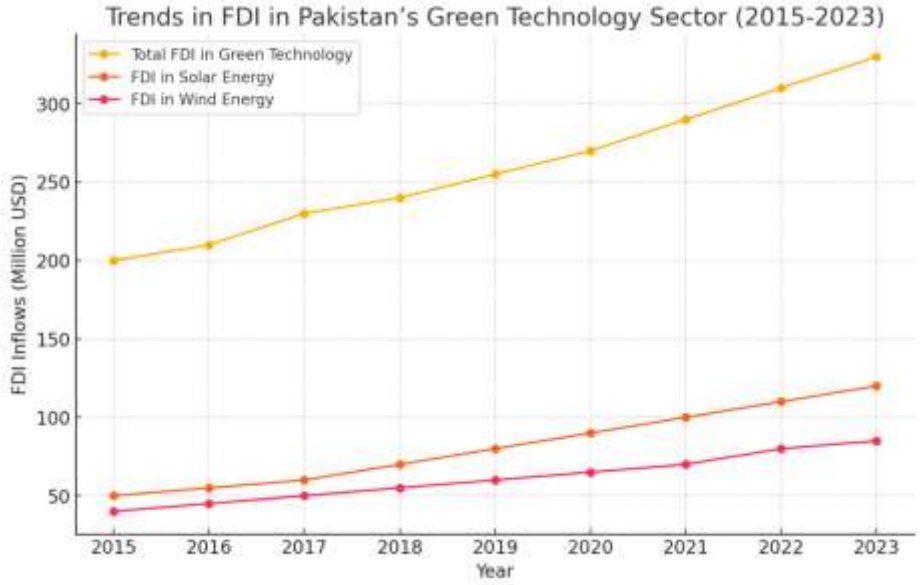
The effects of Pakistan's trade policies appear to be both positive and negative towards green technology. On the one hand, SAFTA, GSP+ of European Union have made provisions for market access of green technology. However, the lack of directional provisions such as specific preferences for green technology imports and exportation has unfavourably impacted on growth of this sector. In addition, the high tariffs on the environmental goods and missing harmonization of the specialized trade agreements dedicated to green technology have not allowed these technologies to spread in Pakistan (Akhtar & Butt, 2023).

Foreign Direct Investment (FDI) is a very important factor in the development of green technology industry in Pakistan. But the FDI in this area has been difficult to attract due to political and economic instability of the country. However, there are some success stories of FDI in Pakistan's renewable energy sector especially in the solar and wind power generation. Such investments have been made possible by the government policies like tax exemption and guaranteed tariffs for producers of renewable energy. However, for Pakistan to make the best out of FDI in green technology, it requires a stable and predictable investment climate besides better IPR protection (Sial & Asim, 2023).

Table 2: International Partnerships in Green Technology

Partnership	Description	Impact on Green Technology
China-Pakistan Economic Corridor (CPEC)	Collaboration on renewable energy projects	Enhanced renewable energy capacity, IP protection concerns
UNFCCC and Paris Agreement	Commitment to global climate goals	Slow domestic implementation of green technology initiatives
World Bank & Asian Development Bank	Funding and support for green technology projects	Infrastructure development, dependent on continued support

Graph Example: Trends in FDI in Pakistan's Green Technology Sector (2015-2023)



Challenges and Opportunities in Protecting Green Technology in Pakistan

The legal and regulatory aspects of green technology in Pakistan present substantial risk to the overall protection of green technology, mainly because of the difficulties in implementing suitable international frameworks on the national level. The international agreement such as TRIPS and the Paris Convention provide sound legal protection for IPs; nevertheless, their implementation in the context of Pakistan legal system shows significant challenges. The major drawback is that such standards are unchangeable and still not comply with socio-economic conditions of developing countries such as Pakistan (Khan & Iqbal, 2023).

Despite the fact that Pakistan's legislation conforms to most of the international instruments, the issue arises in the enforcement of the standards set by these treaties. The country's IP laws such as the Patents Ordinance of 2000 do not have the necessary detail that can be used to support green technologies. These laws were not drafted with the existing difficulties of environmental technology in mind, and thus there is a misfit between the legal prescriptions and the green technology

innovators. Furthermore, there are no specialized IP courts and qualified judicial officers, which only worsens the situation, because the protection of IP rights becomes rather unstable and uncertain (Ahmed & Siddiqui, 2022).

These difficulties are further exacerbated by regulatory gaps. The IPO-Pakistan and other Pakistan's regulatory bodies experienced severe resource constraints and not have the adequate technical skills to manage and protect green technology patents. This means that the protection of patents through registration is a slow and cumbersome process that is compounded by weak enforcement mechanisms hence underlining the ineffectiveness of the IP system. This not only inhibits innovation but also reduces the competitiveness of Pakistan to foreign investors intending to invest on research and development and deployment of green technologies within the country (UNCTAD, 2023).

The economic and finance situation in Pakistan is very challenging, thus making it very difficult to encourage the development and protect green technology. One of the main problems is high costs that are connected with research and development in the sphere of green technologies; high costs are even more critical in the context of the country where other financial issues are already critical due to the general economic problems. There are no cheap sources of financing green technology projects, which hinders innovation and implementation (Malik & Rashid, 2023). However, these domestic financial issues are not the only constraints that Pakistan faces; the country has limited options of financing large scale green technology projects because of its limited access to the international financial markets. Due to the lack of a sound green finance industry, these tools such as green bonds or climate funds are not present to address this problem. As a result, the actual cost of the development and deployment of green technologies remains on the government and the private sector, which are not in a position to bear this cost alone (Sial & Qureshi, 2022).

However, these financial factors also imply apparent large possibilities for the international financial assistance and funding. Multilateral institutions including the World Bank, the Asian Development Bank and the Global Environment Facility have over the years come to realize the need of financing green technology development in the developing regions. These institutions provide various types of funds such as grants, low interest loans, technical assistance which can play a vital role in funding the green technology in Pakistan. Also, the effort towards creating a better investment environment by undertaking policy changes and financial incentives could help attract FDI that could help ease some of the economic challenges in Pakistan (World Bank, 2023).

Opportunities for Enhancing Protection

However, the following are some opportunities that can be taken to enhance the protection of green technology in the country. Another area that requires enhancement is related to the enhancement of the current policies on protection of the IPR hence boosting the green technologies. This could mean changing the Patents Ordinance, 2000, to include provisions that would fast track the patenting process for green technologies as well as afford further protection to innovations, which have positive environmental impact (Khan & Ahmed, 2022).

The third major opportunity relates to the promotion of international partnership to improve the status of IP and technology transfer. The organizations which Pakistani can seek help from include the World Intellectual Property Organization and the United Nations Environment Programme. They can go a long way into developing the requisite human capital within Pakistan's legal and regulatory systems to protect green technologies. Moreover, the bi- and multilateral agreements concerning technology transfer can promote the diffusion of green technologies in Pakistan, and make the latest achievements and best practices available to local inventors (UNEP, 2023).

PPPs also offer a good chance for improving the legal framework for green technologies protection and their further commercialization. Therefore, the Pakistan government needs to encourage improved relations between the two sectors, where government organizations can promote innovation for green technologies' development and implementation. Such partnerships may also assist in the elimination of financial and technical constraints to advance green technology solutions nationwide (Qureshi & Iqbal, 2022).

Conclusion

The case of Pakistan highlights that international strategies are useful for the protection of green technology comprising of collaboration, technology transfer, and IPR. Pakistan also suffers from climate change and pollution and thus requires green technology to support sustainable development.

However, the extent of protection of IPRs on the one hand and distribution of innovation on the other hand continues to be a concern. Partnership with other countries, the solidification of IPR laws, and active involvement in treaties such as the Paris Agreement is crucial for the promotion of technological development and for Pakistan to be able to incorporate renewable energy technologies that would help in meeting its environmental and economic objectives.

Recommendations

A. Policy Recommendations for Pakistan

In order to address the challenges and to build strength from the opportunities of protection of green technology in the country, there are several policy measures described below that needs to be employed by Pakistan. First, there is the need for the improvement of the current IP legislation and IP protection measures. This could be done by amending the existing legal framework to provide for green technology where provisions involving early release of patents and severe penalties for infringement are included. Moreover, these authorities came up with specialized IP courts and the education of the judiciary and enforcement officers on green technology related IP concerns would greatly improve the protection of such technologies (Siddiqui & Abbas, 2023).

Moreover, Pakistan needs to pay more attention towards strengthening its technology transfer and innovation environment. This requires establishing favourable policy conditions for technology transfer especially in eco-technology field. The government should actively promote private–public collaborations and offer subsidies in the form of tax deductions and/or grants for green technology R&D by companies. The improvement of the position of research institutions and universities in innovation and technology transfer is also another strategy of ensuring sustainability of green technology (Malik & Rashid, 2023).

Another influential dimension of the Pakistani strategy for protection of green technology is the encouragement of regional integration. Therefore, by participating more actively in global processes and cooperation, Pakistan can acquire new technologies and practices without which it is impossible to overcome domestic issues. This also involves the engagement of the country with other nations and its membership in international organization that set the policies on IP and the environment. Enhancing cooperation with International Organizations; WIPO, UNEP and WTO will help keep Pakistan in line with current global initiatives on green technology (UNEP, 2023).

B. Recommendations for International Stakeholders

Governments, international organizations and multinational companies across the world have a responsibility to extend their support towards the protection of green technology in the developing countries such as Pakistan. As a result, stakeholders can consider the following recommendations to build on global endeavors in this area.

First of all, the members of the international community should persistently support technical cooperation and capacity development initiatives that are relevant to the requirement of the developing nations. Such programs should therefore emphasize on the reinforcement of the legal and regulatory requisites associated with the promotion of green technologies. Furthermore, international organizations should encourage the adoption of green technology protection clauses in GATS so that the environmental question is not left out in the trade liberalization process (WIPO, 2023).

The protection of green technologies also needs international cooperation. Global players should encourage the dissemination of best practices and development of an International norm on the protection of green technology. This involves promoting technology transfer through systems that respect IP rights but at the same time avail technologies that developing countries need to cope with environmental issues. Multifaceted approaches, including cooperative agreements in research programmes and networks spanning the border will remain vital in promoting the green technology concept in the global sphere (UNEP, 2023).

Last but not the least, the multinational corporations and investors must be aware that developing countries like Pakistan could one day become potential markets for green technology. International stakeholders can play their part in the nurturing of the green technologies and their relevant IP by investing in these markets and joining the innovation ecosystems in the specific regions, while at the same time reaping the benefits of the growth that belongs to these emerging markets (Sial & Qureshi, 2022).

Tables and Graphs

Table 1: Key Legal and Regulatory Challenges in Protecting Green Technology

Challenge	Description	Impact on Green Technology
Adapting International Strategies	Difficulty in implementing global IP standards within Pakistan's context	Weakens overall IP protection
Regulatory Gaps	Outdated laws and lack of specific guidelines for green technologies	Reduces effectiveness of legal protections
Enforcement Issues	Inconsistent and slow enforcement of IP laws	Discourages innovation and investment

Table 2: Economic and Financial Constraints and Opportunities

Aspect	Description	Impact on Green Technology
Financial Challenges	High costs and limited financing for green technology projects	Hinders development and deployment of green technologies
International Financial Support	Opportunities for grants, loans, and technical assistance	Can bridge financial gaps and support large-scale projects
Investment Climate	Perception of risk and regulatory uncertainty	Limits FDI and hinders growth in the green technology sector

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