# BETWEEN CLIMATE AMBITION AND PATENT REALITIES: INDIA'S USE OF PATENT LAW TO EXPAND ACCESS TO GREEN AND SUSTAINABLE TECHNOLOGIES

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## ABSTRACT

India is among the world's most climate-vulnerable nations, with nearly 80% of its population living in districts exposed to extreme weather events. As climate impacts escalate, from heat waves, crop failures, extreme weather patterns, coastal erosion, and severe water scarcity, the need for accessible and affordable sustainable technologies becomes increasingly urgent. These technologies help reduce emissions and environmental damage. While patent law is considered an important framework to incentivise innovation, it can also be used as a tool to incentivise sustainable and green technologies. However, many of these technologies are controlled by foreign entities with strong patent protection, resulting in India's high dependency on imports and limited capacity for domestic diffusion. This gap is significant, because without timely and equitable access to essential green technologies, India may struggle to meet its climate commitments under the Paris Agreement and its Net-Zero 2070 vision.

In this context, this paper aims to examine how patent law can play a more effective role in strengthening access to sustainable technologies while also supporting domestic innovation. It analyses whether the legal flexibilities available under the Patents Act, 1970—particularly compulsory licensing, government use, and other non-voluntary access mechanisms can provide a practical solution for technology access in climate-critical sectors. The paper also reviews India's national climate missions and industrial policies while examining the technology-access challenges in meeting environmental goals.

Using a doctrinal research approach, supported by case studies from selected climate-related industries, the paper analyses patterns of patent concentration, market barriers to technology transfer, licensing challenges, and India's manufacturing capability. The findings reveal that while India possesses strong TRIPS-compliant flexibilities in law on paper, their actual use is often limited due to legal and political uncertainties, limited institutional capacity, and the risk of international trade pressure.

To address these challenges, this study proposes a policy-oriented framework presenting how Indian IP law can be aligned with climate action and industrial development. The framework highlights how strategic use of patent flexibilities, combined with domestic incentives, public–private partnerships, and stronger innovation ecosystems, can reduce technology dependence and support long-term technological self-reliance. By positioning patent law as part of a broader climate-resilience strategy rather than a standalone solution, this paper offers pathways for India to strengthen its response to climate change and expand access to essential green technologies.

**Keywords:** Compulsory Licensing; Climate Technologies; India; TRIPS Flexibilities; Technology Transfer; Sustainable Development; Climate Adaptation.

## Introduction

There is now enough evidence to say the footprint of climate change can be witnessed in every corner of the globe. India is one among the top climate-vulnerable nations, with nearly 80% of population living in districts exposed to extreme weather events.[1] Factors like poverty, climate-reliance livelihoods and weak infrastructure intensifies the impact of climate hazards in these regions.[2] International climate regime recognise environmentally sound technology as a key solution to climate emergency, as these technologies mitigate and adapt to climate change by reducing greenhouse gas emissions and environmental damage. However, strong patent protection on advanced green technology create barrier for accessibility and affordability, resulting in high dependency on imports and limited capacity for domestic diffusion. This gap is significant, because without timely and equitable access to large-scale essential green technologies, India may struggle to meet its climate commitments under the COP21 and its Net-Zero 2070 vision. This structural tension between India's climate goals and the constraints imposed by patent regimes, which this paper terms the conflict between "climate ambition and patent realities" is discussed in the following.

## India's Climate Vulnerability and the Role of Green Technology

The Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate patterns due to direct or indirect human activity, altering the global

[1] Abinash Mohanty & Shreya Wadhawan, Mapping India's Climate Vulnerability: A District Assessment (Council on Energy, Env't & Water 2021)
[2] *Id.*

atmospheric composition over comparable time periods[3]. Anthropogenic activities such as fossil fuel burning, deforestation and industrial emissions largely attributes to the alterations in temperature, precipitation, and other atmospheric parameters[4].The IPCC defines climate change vulnerability as "the degree to which a system is susceptible to and unable to cope with the adverse effects of climate change, including climate variability and extremes. Hence, climate vulnerability is the magnitude and rate of climate change and its variation to which a system is exposed, the sensitivity and the adaptive capacity of the system"[5].Climate vulnerability also extends to variety of concepts and elements, that are sensitive and susceptible to harm, and are incapable to adapt to climate change impacts[6].

India's position on climate vulnerability reveals its uniquely precarious position in the global climate landscape. Although India contributes a relatively modest share of emissions of historical greenhouse gases compared to industrialized nations,[7] yet it remains highly vulnerable to the climate related changes. The Global Climate Risk Index 2019[8], marks India as the seventh most vulnerable nation out of 181 countries to high exposure and vulnerability to extreme weather events. As per the climate vulnerability index released by the Council on Energy, Environment and Water (CEEW),80 per cent of India's population living in districts are vulnerable to extreme weather events[9]. India was also placed as the second most country in the 'severe risk' nations in the world, subjected to environmental and climate change hazards[10].

India's climate vulnerability is not caused by a single factor and is due to its fragile ecological geographical structure, economic systems, and low-income level among most of the citizens limit India's ability to cope up with climate change impacts.[11] Also, the rapid industrial activity magnifies sector-specific $CO_2$ emissions from four major sectors, such as Electricity (35.05%), Agriculture (23.18%), Construction/Manufacture (15.92%), and Transport (8.64%)[12]. These

[3] United Nations Framework Convention on Climate Change art. 1, May 9, 1992, 1771 U.N.T.S. 107.
[4] Intergovernmental Panel on Climate Change, Climate Change 2021: The Physical Science Basis (Valérie Masson-Delmotte et al. eds., Cambridge Univ. Press 2021).
[5] IPCC definitions
[6] Defintion (IPCC: Fifth Assessment Report 2014)
[7] India has only 3% historical $CO_2$ emissions compared with 25% by the US and 17% by the EU over 1850-2019
[8] Jan Burck et al., Climate Change Performance Index 2019 (Germanwatch, NewClimate Inst. & Climate Action Network Int'l 2019).
[9] Mohanty & Wadhawan, Mapping India's Climate Vulnerability, supra note 1
[10] Rajeev Kumar et al., *Review of Various Climate Change Exacerbated Natural Hazards in India and Consequential Socioeconomic Vulnerabilities*, at 1 (2023)
[11] Amulya K. N. Panda, *Assessing Vulnerability to Climate Change in India*, 44 Econ. & Pol. Wkly. 105, 105–07 (2009), https://www.jstor.org/stable/40279163
[12] Imani Tiseo, *Distribution of GHG Emissions in India 2020, by Sector*, Statista (2023), https://www.statista.com/statistics/<specific-statistic-ID> (last visited Jan. 25, 2026).

activities have contributed to the atmospheric concentration of greenhouse gases (GHGs), which trap heat and cause global warming.[13]

As a consequence of climate change, India faces extreme weather events, which not only cause discomfort but also lead to increased mortality rates and disruptions to daily life and infrastructure. Around 40% of the overall population resides on India's coastline and is severely affected by rising sea levels, increased cyclones, saltwater erosion and chronic flooding, disrupting the coastal and transitional ecosystem. Likewise, India’s agrarian economy was adversely impacted due to changes in rainfall patterns and a rise in temperature, increasing the impact with visible consequences on food security, cropping patterns, productivity, and economic sectors. Droughts are expected to become more common in the following decades, leading to groundwater depletion, resulting in 20 per cent loss on food crops across the country and sixty- eight percent loss in regions expecting poor ground water supply in future.[14]Apart from agriculture, other Indian industries like fisheries and tourism are also threatened by climate impacts like an increase in temperatures and extreme weather conditions.[15] In addition, the environmental and social factors such as clean air, safe drinking water, food security and shelter are also impacted, affecting people’s livelihood, health, and security. Hence, climate change became a multifaceted crisis affecting India’s environment, economy and people, requiring an urgent need for a steadfast solution.

Green technologies, also known as clean or environmentally sound technologies,[16]are viewed as an effective measure to address climate challenges. The 1992 Rio Declaration defines green technologies as technologies that ‘protect the environment, are less polluting, use all resources more sustainably, recycle more of their wastes and products, and handle residual waste in a more acceptable manner than the technologies they replace’[17] These clean and sustainable technologies are proven to mitigate climate change through the adaptation of Renewable energy technologies (RETs),[18]clean manufacturing processes, efficient water management

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[13] M. A. Nawaz et al., *Nexus Between Green Finance and Climate Change Mitigation in N-11 and BRICS Countries: Empirical Estimation Through Difference-in-Differences (DID) Approach*, 28 Envtl. Sci. & Pollution Res. 6504, 6504–19 (2021).

[14] Ghosh, A. & Chaturvedi, M., Impact of Climate-Induced Infrastructure Challenges on India’s Economy, 18 J. Dev. Econ. 178 (2019).

[15] *Id*.

[16] Intergovernmental Panel on Climate Change, Annex B: Glossary of Terms, in Climate Change 2001: Impacts, Adaptation, and Vulnerability (2001)

[17] Rio Declaration on Environment and Development, June 14, 1992, U.N. Doc. A/CONF.151/26 (Vol. I).

[18] which uses Renewable energy from resources such as solar, wind, hydro, tidal, ocean waves, and geothermal to generate energy rather than to depend on natural resources for energy needs

techniques and climate-resilient agricultural practices as both mitigation and adaptation strategies. Given India' climate vulnerability, the need for adaptation technologies are more essential rather than mitigation.

In order to achieve India's climate goal to become greener and cleaner carbon-free economy, a large-scale deployment of advanced green technologies is non- negotiable. However, accessibility to these technologies is skewed, especially between developed and developing countries[19] leading to uneven distribution in latter. This gap creates restraints for access to green technology.

**Global Green Technology Transfer: Trends, Barriers, and Implications for Developing Countries.**

Recent data indicate a sustained increase in global investment in green innovation with 3.46 million patent applications in 2022 worldwide, with robust growth over 9 per cent in battery and clean energy generation technology.[20] Despite the progress, many developing countries lag behind in filing[21] and a similar disparity can be witnessed in clean technology investments and manufacturing capacities. Worldwide spending on energy transition also reached over $2 trillion in 2024,[22] yet most of this investment and productive capacity is concentrated in a few economies like China, the USA, and the European Union, accounting nearly 70 per cent of global clean energy investment.[23] On the other hand, developing countries contribute only a small share of capital, reinforcing the technological disparity between rich and poor economy. In this context, international trade plays a pivotal role in expanding green technologies across borders but the distribution of this trade also highly concentrated towards few dominating countries like China, Germany, and the USA, accounting for nearly 43 per cent of global environmental goods export.[24] In contrast many developing countries like Brazil and India Brazil import far more clean technology equipment than they export. To put it simply, few

[19] Hanna Fekete et al., *A Review of Successful Climate Change Mitigation Policies in Major Emitting Economies and the Potential of Global Replication*, **137** Renewable & Sustainable Energy Rev. 110602 (2021).
[20] World Intellectual Property Organization, *World Intellectual Property Indicators 2023* 9, 38 (2023), https://www.wipo.int/publications/en/details.jsp?id=4678
[21] Barasha Borthakur, *Who Owns What? The Patent Landscape of Environmentally Sound Technologies*, 18 J. Intell. Prop. L. & Prac. 566, 568 (2018).
[22] Statista, *Global Investments in Clean Tech*, https://www.statista.com/study/36463/global-investments-in-clean-technology-statistia-dossier/ (last visited Jan 23, 2026)
[23] *Id.*
[24] Genevieve McInnes, *OECD Work on Trade and the Environment—A Retrospective, 2008–2020*, 22–23, https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/trade-and-environmental-sustainability/oecd-trade-environment-retrospective-2020.pdf (last visited Jan. 25, 2026).

large economy controls world's clean technology trade, while small economy remain on the fringes of this trade. Factors like limited financial resources, lack of technical skills, poor infrastructure and competing development priorities affect the capacity to sustain climate change mitigation efforts in these countries.[25]

Moreover, the fragmentation across intellectual property and climate regimes impedes the effective transfer of environmental sound technologies in international economic law. International agreements like UNFCCC 1992 and the Paris Agreement 2015 calling on developed countries, to promote the transfer of environmental sound technologies. Article 4.5 of UNFCCC cast positive obligation on developed countries to assist the transfer and know-how of green technologies, and parties reached consensus such transfer from developed to developing countries is essential to mitigate climate change impacts. Similarly, the Paris Agreement also emphasises on technology development and transfer.[26] Altogether these provisions reflect global dedication to combat climate change.

In contrast, the international framework of trade and intellectual property often conflicts with this goal, as it protects technology as a commercial asset. Article 7 of TRIPs Agreement recognises the transfer and dissemination of technology and be a mutual advantage for both producers and users of intellectual property.[27] Article 8.2 further recognises that members may adopt measures to prevent abuses of intellectual property rights that 'adversely affect the international transfer of technology[28] and whereas Article 40 allows members to define, under their national laws, what constitutes an abuse of IPR in licensing that may affect technology transfer. Though these articles legitimise state intervention against IP-related practices that harm technology transfer,[29] their vagueness and reliance on domestic interpretation may limit international coherence, and the non-uniformity poses a problem for cross-border enforcement, particularly in regulating internationally anti-competitive practices. In addition, Article 66.2 puts only an affirmative obligation for technology transfer on developed country governments. Under Article 66.2, developed members shall provide incentives to enterprises and institutions

[25] C. Zhang, I. Khan, V. Dagar, A. Saeed & M. W. Zafar, *Environmental Impact of Information and Communication Technology: Unveiling the Role of Education in Developing Countries*, 178 Technol. Forecast. Soc. Change 121570 (2022).
[26] Paris Agreement, arts. 10–11, Dec. 12, 2015, 55 I.L.M. 740 (2016).
[27] Agreement on Trade-Related Aspects of Intellectual Property Rights, 1869 U.N.T.S. 299 (1994)
[28]World Trade Organization, *Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS): General Provisions*, https://www.wto.org/english/tratop_e/trips_e/t_agm0_e.htm (last visited Jan. 25, 2026).
[29] R. Eberhard Tundang, *US–China Trade War an Impetus for New Norms on Technology Transfer*, 54 J. World Trade (2020).

in their territories for the purpose of promoting and encouraging technology transfer to Least Developed Country members to enable them to create a sound and viable technological base. Even after two decades of TRIPs, compliance with Article 66.2 has been patchy, as the WTO noted only incremental progress and few concrete results in fostering LDC technological capacity. In other words, strict IP protection under the WTO's Agreement on TRIPS may conflict with the UNFCCC's mandate to disseminate climate-friendly technologies; thus, the international legal tools failed to bridge the gap between IP protection and global technology diffusion.[30]

However, the vast repositories of patent information also serve as a valuable resource for the direction of technological development and identifying new areas for scientific and commercial inquiry for researchers and entrepreneurs[31]. Further, IP rights facilitate the process of technology transfer and collaborative ventures. Licensing agreements enable right holders to strategically disseminate their innovations, reaching markets and applications that might otherwise remain inaccessible. Such arrangements can foster a more rapid and widespread adoption of new technologies.[32] In this context, the role of IP in facilitating or hindering green technology transfer can be understood by examining empirical evidence on IPRs and low-carbon technology transfer.[33] Firstly, IPRs do not seem to prohibit access per se by developing country firms to the low carbon technologies, and this is particularly the case in rapidly developing countries such as India and China. Secondly, although IPRs might not prohibit access to these technologies, they do seem to play a part in prohibiting access to variants of these technologies at the cutting edge.[34] Studies[35] indicate that "it took China and India less than ten years to go from having companies with no wind turbine manufacturing experience to companies capable of manufacturing complete wind turbine systems, with almost all components produced locally. This was done within the constraints of national and international intellectual property law, and primarily through the acquisition of technology

[30] Ronald Eberhard Tundang, *Aligning Climate Needs and Intellectual Property: An Entitlement-Based Framework for Green Technology Transfer* (2020).
[31] E. Kwakwa & P. Oksen, *How the IP System Promotes Sustainability – The WIPO GREEN Initiative*, in Jacques de Werra (ed.), *Intellectual Property and Sustainable Development* 123 (Univ. of Geneva 2024).
[32] World Intellectual Property Organization (WIPO), *Sustainable Fashion Technologies: Stitching Sustainability into Style* (Geneva: WIPO 2025), https://doi.org/10.34667/tind.58680
[33] David G. Ockwell, Ruediger Haum, Alexandra Mallett & Jim Watson, *Intellectual Property Rights and Low Carbon Technology Transfer: Conflicting Discourses of Diffusion and Development*, 20 Glob. Envtl. Change 14 (2010), https://www.elsevier.com/locate/gloenvcha
[34] I*d.*
[35] J. I. Lewis, *Technology Acquisition and Innovation in the Developing World: Wind Turbine Development in China and India*, 42 Stud. Comp. Int'l Dev. 208 (2007).

licenses or via the purchasing of smaller wind technology companies." While mechanisms such as joint ventures and strategic acquisitions facilitated successful technology access, this access is sectorally limited and uneven across technological sectors and stages of development. In practice, patent over key technological components, restrictive licensing terms, and high costs might reduce developing country's access to the know-how which are essential for sustained technology capacity building. This implies that access to intellectual property rights per se, will not enable such capacity building rather it is to understand that such access facilitates developing countries to understand, work on and imitate the knowledge that underlies new low-carbon technologies.[36] However, if the developing country's firms agenda to assimilate new technologies and increase domestic technological capacity in lieu of clean technology dissemination, then developed country's firms likely to use patent protection to prohibit such access.[37]These constraints are particularly relevant for developing countries like India, with its ambitious climate goals, seeking not only large-scale deployment of these technologies but also long-term technological learning, adaptation, and domestic innovation, thereby limiting their capacity to independently develop and upgrade green technologies.

In this context, it is crucial to examine how domestic legal framework be used to mitigate such barriers. Therefore, the following section examines whether and how the flexibilities embedded within Patent Act 1970 used to expand access to essential green technologies and support domestic capacity building.

**The Patents Act, 1970: Access for Green Technologies**

The Patents Act, 1970, encompasses dual legal framework that can either facilitate nor hinder access to green technologies as well as domestic innovation and determined on the implementation of specific provisions and the extent to which the appropriate government machinery utilises it. The concept of technology transfer is inherent in the structure of the Act, reinforcing the legislature's intent that mere grant of exclusive rights will not suffice for meaningful technological development. For a country whose governance is based on the social welfare model, the grant of a patent cannot be limited to incentivising innovation. The real test is one of utility. The notion of utility under patent law thus assumes a dual dimension—individual utility accruing to the patentee, and social utility that advances public interest

[36] World Intellectual Property Organization (WIPO), supra note 32
[37] J. I. Lewis, supra note 35

goals.[38] For instance, the high fee of licensing a patent may increase the production and usage costs or the patentee may refuse to grant a licence, are barriers to entry.[39] For instance, DuPont refused to grant licence for chlorofluorocarbon substitutes to Korean and Indian firms[40] and such a refusal as proprietary control can delay technological diffusion and impede compliance with environmental obligations. Given this context, the Patents Act must be examined not merely as a system of private rights but as a regulatory instrument to reconcile patent protection with the urgent need for green technology dissemination.

The Act is made upon general principles that govern the exercise of patent rights, specifically emphasising that patents are not merely for the "enjoyment of a monopoly"[41]and shall facilitate transfer and dissemination of technology to the mutual advantage of producers and users in a manner conducive to social and economic welfare.[42] Moreover, patents acts an instrument to promote public interest, especially in sectors for India's socio-economic and technological development[43]reinforcing its role in achieving national developmental priorities. It is to ensure that inventions are worked in India on a commercial scale and to the fullest extent reasonably practicable.[44]This indicates legislative intent for local manufacture and capacity building, rather than mere importation of patented technologies, thereby calling for patent protection with domestic industrial growth and technological independence.

When essential green technologies are held under restrictive monopolies, the Act provides several "non-voluntary" routes to ensure access. Under Section 84, any interested person can apply for a compulsory license after three years if the patented invention is not available at a affordable price, the reasonable requirements of the public are not satisfied, or the invention is not worked in India. Also, section 92 allows the government to notify a patent for compulsory license in circumstances of national emergency, extreme urgency, or public non-commercial use.[45] In such cases, the Controller can bypass standard procedures to ensure technology is available at the lowest price.[46] In addition, Section 100 empowers the Central Government to

[38] Rohan Cherian Thomas, *A Legal Analysis of Transfer and Compulsory Licensing of Green Technology in India to Mitigate Climate Change*, 8 Envtl. L. & Prac. Rev. 60 (2025)
[39] Reiko Aoki & John Small, *Compulsory Licensing of Technology and the Essential Facilities Doctrine*, 16 Inf. Econ. & Pol'y 13 (2004)..
[40] "Technology Transfer Stops at Paper Promises," *South Bulletin*, 19–30 Aug. 2001, South Centre, Geneva
[41] Patents Act, 1970, S 83 (India)
[42] Patents Act, 1970, S 83(c) (India
[43] Patents Act, 1970, S 83(d) (India)
[44] Patents Act, 1970, S 83 (g) (India)
[45] Patents Act, 1970, § 92 (India).
[46] *Id.*

use any patented invention for its own purpose, and this includes the right to sell goods on a non-commercial basis.[47] If necessary for a public purpose, the government can acquire a patent entirely by notifying the patentee and providing compensation.[48] Together, these provisions form a robust legal foundation to address monopolistic barriers in climate-sensitive sectors.

In addition to access, the Act also allows any person to make or use a patented invention for experiment or research, including the imparting of instructions to pupils[49]. This is crucial for domestic innovators to adapt, and improve upon existing green technologies. Section 91 further allows an innovator who has a new invention that cannot be worked without using an existing patent to apply for a license, provided their invention makes a substantial contribution to industrial activities in India. Additionally, patents of addition under section 54 permit domestic firms to seek patents for improvements or modifications of a "main invention," encouraging green innovation without the burden of separate renewal fees. The Bolar exception under section 107A ensures that acts related to developing and submitting information for regulatory approval (in India or abroad) are not considered infringement, allowing local industries to enter market immediately upon patent expiry.

The Act also addresses the risk of anti-competitive licensing practices that may hinder technology diffusion. Section 140 declares void any condition that forces a licensee to acquire non-patented articles from the licensor or prohibits them from using competing processes. Once a patent expires, the licensee has the right to terminate the contract by giving three months' notice, ensuring that expired patents do not continue to hinder industrial activities[50]

While the Act facilitates access, certain provisions can also act as barriers. Section 48 grants patentees the exclusive right to prevent third parties from making, using, or selling the product/process in India without his permission. If exercised aggressively without government intervention, this can lead to high costs and limited supply.[51] The 20-year term may be seen as a hurdle for the rapid deployment of essential climate technologies.[52]

Hence, the exclusive rights and 20-year protection can hinder access by creating high-cost

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[47] Patents Act, 1970, § 100(6) (India).
[48] Patents Act, 1970, § 102 (India).
[49] Patents Act, 1970, § 47(3) (India).
[50] Patents Act, 1970, § 141 (India).
[51] Patents Act, 1970, § 48 (India).
[52] Patents Act, 1970, § 53 (India).

monopolies and the general principles on the other hand like compulsory licensing, and research exemptions facilitate access. By leveraging these provisions, the patent law can act as a powerful catalyst for domestic innovation and ensure green technology dissemination to meet the urgent needs of the climate-critical sector.

**India's Low-Carbon Development Goals and Barriers to Green Technology Access**

India's climate goals are rooted in the principle of equity and "common but differentiated responsibilities and respective capabilities" (CBDR-RC). India's commitment to combat climate change ensure economic development and growth and net-zero by 2070.[53] The Nationally Determined Contributions (NDC), targets a 45% reduction in the emission intensity of its GDP by 2030 from 2005 levels, and aims to meet 50% of its cumulative installed electric power capacity from non-fossil fuel-based energy resources by the same year.[54] India's climate strategic framework is primarily governed by the Long-Term Low-Carbon Development Strategy (LT-LEDS), which rests on seven key transitions, and the National Action Plan on Climate Change (NAPCC), which currently encompasses nine national missions. Additionally, the Mission LiFE (Lifestyle for Environment) serves as a global movement to shift consumption toward the "mindful and deliberate utilisation" of resources.

However, the implementation of these missions is constrained by deep upstream vulnerabilities, significant intellectual property asymmetries, and structural market barriers. Patterns of patent concentration in green technology remain highly uneven. Between 1975 and 2017, India contributed only 0.2% of global green patents, while Japan (18.6%), China (17.7%), and the United States (17.1%) dominated the field.[55]In the solar photovoltaic sector, India faces a high technical lock-in regarding upstream equipment; technologies for polysilicon reactors (Siemens process), precision wire saws, and crystal growth are heavily patented and controlled by a few global entities[56]In the wind energy sector, 90% of the processing for rare-earth oxides is concentrated in China. Similarly, in the battery sector, 80% of the global supply

[53] Ministry of Environment, Forest and Climate Change (MoEFCC), *India's Long-Term Low-Carbon Development Strategy* (2022).
[54] *Id.*
[55] United Nations Conference on Trade and Development (UNCTAD), 2023
[56] A. Tiwari, *India's PV Manufacturing and Its Strategic Inflection Points* (The Energy and Resources Institute, New Delhi 2026).

chain and 55% of cathode capacity are controlled by just a few countries and companies.[57]

India's manufacturing capabilities reflect a structural imbalance, with strength concentrated in downstream assembly rather than upstream material production. In Solar PV, India has achieved significant scale in module assembly (120–144 GW capacity), yet it remains almost entirely dependent on imports for polysilicon (100%) and wafers (98%).[58] And in wind energy, India is a global leader with 70–80% indigenization; however, its turbines are roughly 30% more expensive than Chinese models due to the high cost of specialised steel and components.[59]The battery sector remains nascent and largely limited to low-value-added battery assembly, lacking at-scale production for high-value components like cathodes, anodes, and cells[60]

As a result, India has emerged as a major net importer of critical clean energy components, facing a $3 billion annual bill for lithium-ion imports alone. [61]These sectoral challenges are compounded by multiple systemic barriers, including high costs of finance, in which Indian manufacturers face interest rates of 9.5% to 10.25%, compared to 3–4% available to Chinese competitors. Infrastructure bottlenecks arising from limited certified laboratories for the technical certification of equipment cause delays in market entry and vulnerabilities in access to critical minerals such as lithium, cobalt, and rare earths, with domestic mining auctions receiving limited responses, which are barriers. Lastly, policy inconsistency and the shifts in import duties and the temporary suspension of the Approved List of Models and Manufacturers (ALMM) have created uncertainty for long-term investments.[62] Together, these factors illustrate how patent concentration, market structures, and industrial constraints intersect to shape India's access to green technologies.

**Conclusion**

Based on the doctrinal analysis and sectoral case studies, this paper proposes a policy-oriented

[57] Dhruv Warrior, Vibhuti Chandhok, Abhinandan Khajuria, Shruti Gauba & Rishabh Jain, *Strengthening India's Clean Energy Supply Chains: Building Manufacturing Competitiveness in a Globally Fragmented Market* (Council on Energy, Environment and Water, New Delhi 2024)
[58] A. Tiwari,supra note 54
[59] Warrior et al., supra note 55
[60] *Id.*
[61] Warrior et al., supra note 55
[62] Dhruv Warrior, Vibhuti Chandhok, Abhinandan Khajuria, Shruti Gauba & Rishabh Jain, *Strengthening India's Clean Energy Supply Chains: Building Manufacturing Competitiveness in a Globally Fragmented Market* (Council on Energy, Environment and Water, New Delhi 2024)

framework for aligning patent governance with climate action and industrial development. The framework rests on four interrelated pillars: reorienting IP governance, integrating with climate and industrial policy, strengthening technology diffusion mechanisms through international finance support and inclusive domestic innovation support.

Prioritise green technologies in patent administration through Fast-track "green patent" examination and reduce fees for climate-mitigation and adaptation technologies, drawing on accelerated green patent models and eco-patenting incentives and a dedicated "Green Technology Cell" within the patent office to build technical expertise and coordinate with climate agencies[63]. For the strategic use of patent flexibilities, issue clear guidelines for using compulsory licences, government use, experimental use, and broader research exemptions for essential green technologies, will require careful delineation of terms such as what qualifies as a 'climate emergency' triggering special measures; what is the value of public R&D in climate innovation; how to set 'adequate remuneration' for inventors under compulsory licensing; and which technologies are deemed 'essential'[64] particularly where market failures or abuse of dominance restrict access. To integrate IP with climate and industrial policy, it is urgent to align IP incentives with national climate missions (e.g., solar, green hydrogen, storage) so publicly funded R&D results in technologies that are patent-protected but licensed on fair, reasonable, and non-discriminatory (FRAND) or open terms where appropriate.[65] Use patent pools and collaborative licensing platforms for priority technologies (renewables, grid management, energy efficiency) to reduce transaction costs and accelerate industrial deployment.[66] Also by encouraging green entrepreneurship and SMEs (subsidised filing, legal aid, patent landscaping services) and through capacity-building programmes on IP strategy for universities, public labs, and local enterprises engaged in green R&D, including guidance on licensing, patent pooling, and open model, can help in building inclusive and domestic innovation[67]

This article also acknowledges the limitations and challenges of this approach. All these

[63] Z. Khan & S. Singh, *Intellectual Property Rights Regime in Green Technology: Way Forward to Sustainability*, 22 Nat. Envtl. & Pollution Tech. https://doi.org/10.46488/nept.2023.v22i04.040 (2023)
[64] Ronald Eberhard Tundang, supra note 32
[65] M. Miyamoto & K. Takeuchi, *Climate Agreement and Technology Diffusion: Impact of the Kyoto Protocol on International Patent Applications for Renewable Energy Technologies*, *Energy Pol.*, https://doi.org/10.1016/j.enpol.2019.02.053 (2019.
[66] K. Nithyananda, *Intellectual Property Policy Strategies for Sustainable Manufacturing in India*, 35–[end page] https://doi.org/10.1007/978-981-10-8010-4_4 (2018).
[67] *Id.*

frameworks discussed are natural extensions of the flexibilities present in the climate and IP agreements. In that background, the proposed policy framework should be seen as a pragmatic footprint. Instead of waiting for a comprehensive global treaty solution, it is high time for stakeholders to act by using available legal mechanisms within their restraints to serve our common interest in a sustainable future.