I P BULLETIN

Vol. V and VI (Issue I and II compiled), pp. 1-19

CATALYST-LEVEL PATENT POOLS IN GREEN HYDROGEN ELECTROLYZERS: EXAMINING THE EMERGING COMPETITION LAW VACUUM IN SUB-COMPONENT IP COLLABORATION

Author: Aaransha Shankar[1]

Abstract

The growing divide in the competition law with respect to cooperation in sub-component intellectual property is shown in patent pools at the catalyst level of green-hydrogen electrolysers. The competition law restricts market power, establishes co-operation limits, and prevents distortions in markets like cartelisation and foreclosure of inputs. The patent law, on the other hand, deals with exclusive rights, licensing and innovation incentives. But the majority of the literature overlooks the intersection of the two systems of law in terms of catalyst pooling, particularly in the situations when technology is a necessity and where the supply of stature minerals is limited and the concentration of the Original Equipment Manufacturer (‘OEMs’) is high.

The analysis of how India can overcome this gap as part of the National Green Hydrogen Mission (‘NGHM’) describes that five to six worldwide OEMs possess nearly 95 percent of the proton exchange membrane (‘PEM’) catalyst channel. This hegemony increases the chances of cartelisation, royalty stacking and strategic vulnerability as iridium and ruthenium turn out to be hot world commodities. Our suggested model is a phased, ex-ante governance framework that demands transparency, uses FRAND-based access policies and uses royalty-buydown mechanisms, without making the compliance expenses excessively high to businesses.

A comparative study of the European Union (‘EU’) approaches shows that global regimes face the similar dilemma with fragmented legal framework, offering India a unique opportunity to

[1] B.A. LL.B (Hons.) student at Ram Manohar Lohiya National Law University, Lucknow.

establish the world's first comprehensive regulatory architecture for clean-tech sub-component pools. By enhancing innovation diversity, strengthening localisation under the ₹19,744-crore NGHM, and improving resilience against PGM supply shocks while aligning industrial policy with Sustainable Development Goals ('SDG'), Agenda 21, and Conference of Parties ('COP') commitments, the framework positions India to shape global norms in climate-critical technologies.

Keywords: Catalyst-level patent pools, Green Hydrogen Electrolysers, Competition Law, Sub-Component, Patent Law, National Green Hydrogen Mission.

INTRODUCTION

India's energy transition has entered a decisive phase with green hydrogen becoming the centrepiece of India's clean-energy strategy.[2] The country is working towards reducing fossil fuel dependence,[3] achieving Net Zero by 2070,[4] and emerging as a developed nation by 2047[5] in consonance with the SDGs of Clean Energy.[6] The launch of the NGHM in 2023,[7] with an outlay of ₹19,744 crore until FY 2030,[8] reflects a systemic push to build a domestic green hydrogen ecosystem capable of competing globally.[9]

By 2030, India aims to produce 5 million metric tonnes ('MMT') of green hydrogen annually,[10] backed by 125 GW of dedicated renewable energy capacity.[11] As of May 2025, 19 companies

[2]Akul Raizada, "India Green Hydrogen Strategy in Action Policy Actions, Market Insights, and Global Opportunities", *Ifri Memos*, April 28, 2025, *available at* <India's Green Hydrogen Strategy in Action: Policy Actions, Market Insights, and Global Opportunities> (last visited on 18 Nov 2025).

[3] "India to reducing dependency on fossil fuels, bring down emissions by 45 per cent", *Mid-day,* 17 December, 2023, *available at* <India to reducing dependency on fossil fuels, bring down emissions by 45 per cent> (last visited on 18 Nov 2025).

[4] Alok Kumar, "Why scaling nuclear is critical for net-zero path", *ETEnergyWorld,* 24 November, 2025, *available at* <https://energy.economictimes.indiatimes.com/news/renewable/scaling-nuclear-power-the-key-to-indias-net-zero-goal/125539451> (last visited on 18 Nov 2025).

[5] "Piyush Goyal hails India's defence manufacturing leap, says nation on track for developed India 2047", *The Hans India,* 19 November, 2025, *available at* <Piyush Goyal hails India's defence manufacturing leap, says nation on track for 'developed India 2047'> (last visited on 19 Nov 2025).

[6] Department of Economic and Social Affairs, "Ensure access to affordable, reliable, sustainable and modern energy for all", *The United Nations, available at* <Goal 7 | Department of Economic and Social Affairs>(last visited on 19 Nov 2025).

[7] Ministry of New and Renewable Energy, "NATIONAL GREEN HYDROGEN MISSION (NGHM)", *PIB*, 24 July, 2024, *available at* <Press Release:Press Information Bureau> (last visited on 19 Nov 2025).

[8] Ibid.

[9] "Unlocking India's Green Hydrogen Production Potential", *PIB GoI*, November 2025, *available at* <doc20251112690301.pdf > (last visited on 19 Nov 2025).

[10] Ibid.

[11] Supra note 8 at 1.

have already secured a cumulative production capacity of 862,000 tonnes per year,[12] and 15 manufacturers have been awarded 3,000 MW annual electrolyzer manufacturing capacity.[13] The Mission is projected to attract over ₹8 lakh crore in investments,[14] create 6 lakh jobs,[15] and reduce fossil-fuel imports by more than ₹1 lakh crore,[16] underscoring both the economic and strategic importance of hydrogen to India's long-term energy security.[17]

Yet, beneath this rapid expansion lies a structural chokepoint that could shape and potentially constrain India's green hydrogen ambitions. India's push toward green hydrogen[18] has placed unprecedented pressure on the technology stack of PEM electrolyzers,[19] especially the catalysts.[20] Iridium, Ruthenium, and emerging non-precious metal catalysts[21] determine not only the efficiency of hydrogen production but also its cost.[22] With global Iridium reserves at barely 500 tonnes,[23] control over catalyst innovation has become the real bottleneck in scaling the NGHM.

As global filings in catalyst design, coatings, and membrane-catalyst assemblies rise dramatically,[24] a new form of intellectual property coordination is beginning to surface: catalyst-level patent pools. Unlike traditional system-level pools in telecom or digital standards,[25] these pools operate at the micro-component level inside the electrolyzer where IP concentration is high and alternatives limited.[26] This raises a fundamental dilemma that do

---

[12] Supra note 8 at 2.
[13] Ibid.
[14] Supra note 8 at 1.
[15] Supra note 8 at 2.
[16] Ibid.
[17] Nanditha Parakal Nair and Kumkum Chaudhary, "Hydrogen as a Strategic Fuel for India's Energy Security", *DRaS*, 27 July, 2025, *available at* <Hydrogen as a Strategic Fuel for India's Energy Security - Defence Research and Studies> (last visited on 19 Nov 2025).
[18] "India aims to become world's cheapest producer of green hydrogen by 2030: Former Niti Aayog CEO", *The Economic Times,* 26 November, 2025, *available at* <India aims to become world's cheapest producer of green hydrogen by 2030: Former Niti Aayog CEO> (last visited on 26 Nov 2025).
[19] "India's PSUs target 900 KTPA capacity of green hydrogen by 2030", *The Hans India,* 22 November, 2025, *available at* < India's PSUs target 900 KTPA capacity of green hydrogen by 2030 > (last visited on 22 Nov 2025).
[20] Ernst & Young LLP, "Investment opportunities in India's Green Hydrogen sector", *FICCI*, August 2025, *available at* <Investment opportunities in India's Green Hydrogen sector> (last visited on 20 Nov 2025).
[21] Xiaomei Xu and Taekyung Yu, "Platinum–Iridium–Ruthenium Trimetallic Alloy Nanoparticles as Catalysts for Oxygen and Hydrogen Evolution" 8 *ACS Publication* 3899 (2025).
[22] "Iridium Replaced With Ruthenium in Hydrogen Production", *World Energy*, 24 October, 2022, *available at* <Iridium Replaced With Ruthenium in Hydrogen Production - World-Energy> (last visited on 20 Nov 2025).
[23] "Iridium Industry Statistics, Facts Trends and Data for 2025", *Nikola Roza,* 28 July 2025, *available at* <Iridium Industry Statistics, Facts Trends and Data for 2025> (last visited on 20 Nov 2025).
[24] Miao Ma, Li-Xiao Shen, *et. al.*, *Recent advances in Pt catalysts and membrane electrode assemblies fabrication for proton exchange membrane fuel cell* 4198 (Youke Publishing Co Ltd., Beijing, 2023).
[25]Monica Barbu, Adrian-Victor Vevera, , *et. al.*, *Standardization and Interoperability-Key Elements of Digital Transformation* 87 (Springer Nature, Romania, 2024).
[26] Ibid.

catalyst patent pools promote diffusion in a mission-critical clean-tech sector, or do they risk creating a cartel-like structure over the scarcest input in India's hydrogen economy? India's current legal architecture, both under the Patents Act[27] and the Competition Act[28] has no explicit framework for evaluating competition risks in sub-component clean-tech pooling. This regulatory silence creates a vacuum precisely where policy clarity is most urgent.

In the backdrop of this vacuum, the paper first delves into how catalyst-level patent pools could emerge, secondly it examines how India's existing legal framework engages with them and lastly, what competition risks they pose for electrolyzer manufacturers, clean-tech startups, and the broader hydrogen economy.

EXISTING LEGAL FRAMEWORK & WHY IT DOESN'T FIT SUB-COMPONENT POOLS

A. PATENT LAW (LICENSING, COMPULSORY LICENSING, GOVERNMENT-USE)

A patent pool is an arrangement in which multiple patentees agree to license their patents collectively,[29] through a single entity to streamline access, reduce transaction costs, and avoid overlapping or blocking rights.[30] In simple words, patent pooling involves pooling of technology, resources, expertise, facilities and services.[31] In most sectors, pools are formed for entire technologies or standards (e.g., telecom standards, video codecs),[32] not for highly technical sub-components like electrolyzer catalysts. The Indian Patents Act, 1970[33] does not explicitly mention "patent pools". It provides a general licensing infrastructure under Section 68[34] and Section 69[35] of the Patent Act. Under Section 68 patentees can grant

[27] Indian Patents Act, 1970 (Act No. 39 of 1970).
[28] Competition Act, 2002 (Act No. 12 of 2003).
[29] Nikita Patidar, "Antitrust Scrutiny of Patent Pools in India's green technology and EV markets: Regulatory gaps and Policy needs", *Lawful Legal,* 11 June 2025, *available at* <ANTITRUST SCRUTINY OF PATENT POOLS IN INDIA'S GREEN TECHNOLOGY AND EV MARKETS: REGULATORY GAPS AND POLICY NEEDS » Lawful Legal> (last visited on 20 Nov 2025).
[30] World Intellectual Property Organisation, "PATENT POOLS AND ANTITRUST – A COMPARATIVE ANALYSIS" (March, 2014).
[31] Shama Mahajan, "Patent Pooling and Anti-Competitive Agreements: A Nascent Dichotomy of IPR and Competition Regime" 6 *NLUJ LR* 35 (2020).
[32] Prishita Pandey and Ranish Alia, "The Competition Law Regime and Re-Tooling Patent Pools in India", *Libertatem,* 19 October 2020, *available at* <The Competition Law Regime and Re-Tooling Patent Pools In India -Libertatem Magazine> (last visited on 20 Nov 2025).
[33] Indian Patents Act, 1970 (Act No. 39 of 1970).
[34] Indian Patents Act, 1970 (Act No. 39 of 1970), s. 68.
[35] Indian Patents Act, 1970 (Act No. 39 of 1970), s. 69.

licenses[36] while the licensing agreements can be registered with the patent office under Section 69.[37]

Under Section 84,[38] Indian law allows a third party to apply for a "compulsory license" if the patented invention is not available at a reasonably affordable price or working in India is inadequate.[39] Further, Section 140[40] prohibits certain restrictive or unreasonable conditions in patent licensing agreements such as tying arrangements, resale restrictions, and coercive exclusivity.

While India's patent law provides broad mechanisms for licensing,[41] these tools were historically crafted with pharmaceuticals and essential goods in mind,[42] not with the complexities of clean-tech innovation. Crucially, the Patents Act does not directly regulate, recognise, or even contemplate the formation of patent pools.[43] As a result, there is no statutory framework on how pools in climate-critical technologies should be formed, governed, or supervised, nor any mechanism to evaluate the competition risks that arise when multiple patentees license their technologies collectively. This gap becomes even more pronounced in the context of sub-component pools. The law does not distinguish between pooling entire technologies, such as telecom or multimedia systems, and pooling micro-components like iridium or ruthenium catalysts used in green hydrogen production. Sub-component pools typically involve higher patent concentration,[44] fewer substitutes, and a greater risk of collusion or market foreclosure,[45] yet the Patents Act treats them no differently. In sectors like green hydrogen, where critical inputs are scarce[46] and collaboration is necessary to scale

[36] Indian Patents Act, 1970 (Act No. 39 of 1970), s. 68.
[37] Indian Patents Act, 1970 (Act No. 39 of 1970), s. 69.
[38] Indian Patents Act, 1970 (Act No. 39 of 1970), s. 84.
[39] Competition Law Regime and Patent Pooling - Patent - India
[40] Indian Patents Act, 1970 (Act No. 39 of 1970), s. 140.
[41] Abhinav Gupta and Aqa Raza, "Patent Law and Compulsory Licensing: Indian Perspective" 29 *Journal of Intellectual Property Rights* 5 (2024).
[42] Dr. Payal Thaorey and Anushree Mukte, "Compulsory Licensing of Pharmaceutical Patents in India: Issues and Challenges" 1 *IPR Journal of Maharashtra National Law University, Nagpur* (2023).
[43] Varun Kumar Singhal and Shashi Kiran, "Analysing legal issues in Indian patent law with reference to international intellectual property standards" 11 *International Journal of Law* 18-30 (2025).
[44] World Intellectual Property Organisation, "PATENT POOLS AND ANTITRUST – A COMPARATIVE ANALYSIS" (March, 2014).
[45] Ibid.
[46] Srikant Madhav Vaidya, "From hope to hype: Why green hydrogen isn't delivering", *The Energy World,* 18 October, 2025, *available at* <https://energy.economictimes.indiatimes.com/news/renewable/challenges-hindering-green-hydrogen-adoption-in-india/124639119> (last visited on 20 Nov 2025).

production,[47] this absence of a clean-tech-specific framework creates serious regulatory uncertainty for innovators and investors.

B. COMPETITION LAW

Under the Competition Act, 2002,[48] patent-pooling arrangements fall into an uneasy regulatory space. Section 3 prohibits anti-competitive agreements,[49] including horizontal coordination under Section 3(3)[50] and restrictive vertical arrangements under Section 3(4).[51] Although Section 3(5) provides an exemption for "reasonable conditions" in IP licensing,[52] the Act does not define what "reasonable" means, creating uncertainty for patentees attempting collaborative licensing structures. Section 4[53] adds another layer of risk by prohibiting abuse of dominance, which can apply when IP-holding firms use their patent portfolios to impose unfair or exclusionary licensing terms.[54]

This uncertainty is compounded by jurisdictional ambiguity. The Delhi High Court, in cases involving *Ericsson*[55] and *Monsanto,*[56] suggested that the Patents Act, as a special statute, may prevail over the Competition Act in disputes centred purely on patent licensing, thereby narrowing the Competition Commission of India's ('CCI') supervisory role. Further, it is being questioned whether licensing constitutes a "sale" or "service," raising doubts about whether CCI has jurisdiction over such arrangements at all. This position was subsequently affirmed by the National Company Law Appellate Tribunal ('NCLAT') in *Monsanto Holdings Pvt. Ltd. v. CCI,* wherein the NCLAT upheld the primacy of the Patents Act in matters concerning patent rights and licensing, thereby reinforcing a restrictive interpretation of the CCI's jurisdiction in patent-licensing disputes.

---

[47] Ibid.
[48] Competition Act, 2002 (Act No. 12 of 2003).
[49] Competition Act, 2002 (Act No. 12 of 2003), s. 3.
[50] Competition Act, 2002 (Act No. 12 of 2003), s. 3 cl.(3).
[51] Competition Act, 2002 (Act No. 12 of 2003), s. 3 cl.(4).
[52] Competition Act, 2002 (Act No. 12 of 2003), s. 3 cl.(5).
[53] Competition Act, 2002 (Act No. 12 of 2003), s. 4.
[54] Vikrant Rana and Apalka Bareja, "Competition Law Regime and Patent Pooling", *S.S. Rana and Co.*, 20 June, 2024, *available at* <Competition Law Regime and Patent Pooling - S.S. Rana & Co.> (last visited on 21 Nov 2025).
[55] Telefonaktiebolaget LM Ericsson (PUBL) v. Competition Commission of India, 2016 SCC OnLine Del 1951; Telefonaktiebolaget LM Ericsson (PUBL) v. Competition Commission of India, 2015 SCC OnLine Del 14689.
[56] Monsanto Holdings (P) Ltd. v. CCI, 2020 SCC OnLine Del 598.

Within this fragmented framework, CCI's own view based on its earlier literature and commentary, treats patent pools as potentially restrictive trade practices[57] because they can facilitate price-fixing, foreclose markets by limiting access to non-members,[58] and enable sensitive information-sharing that may coordinate R&D directions or royalty structures.[59] As a result, while Indian law recognises both IP rights and competition concerns,[60] it provides no clear pathway for managing collaborative licensing in climate-critical technologies, especially sub-component pools where the risk of coordinated behaviour is high.

Precious-metal catalysts like iridium and ruthenium are controlled by a very small set of global patentees,[61] while India's domestic manufacturing capacity in these components remains extremely limited.[62] As catalysts account for a significant share of electrolyzer cost,[63] any coordinated licensing or pooling among a handful of rights-holders could sharply influence price, access, and bargaining power. In contrast, non-PGM catalysts show fragmented patenting[64] and lower concentration,[65] making pooling far less risky.

[57] Yogesh Pai and Nitesh Daryanani, "Patents and competition law in India: CCI's reductionist approach in evaluating competitive harm" 5 *Journal of Antitrust Enforcement* 299-327 (2017).
[58]Ambika Aggarwal & Anindya Sircar, "Jurisdictional Changes in Indian Patent Enforcement – Comment on the *Ericsson v. CCI* Decision" 55 *International Review of Intellectual Property and Competition Law* 954-972 (2024).
[59] Akanksha Sharan, "From Flexibility to Formalism: The CCI's Evolving Approach to Cost in Competition Law", *CBCL NLIU,* 25 July, 2025, *available at* <From Flexibility to Formalism: The CCI's Evolving Approach to Cost in Competition Law - NLIU CBCL> (last visited on 22 Nov 2025).
[60] Aniket Ghosh, "Reconciling Innovation and Competition: The Evolving Interface Between IPR and Antitrust Law", *King Stubb & Kasiva*, 7 October, 2025, *available at* <Balancing IP Rights and Competition Law in India> (last visited on 22 Nov 2025).
[61] Changqing Li and Jong-Beom Baek, "Recent Advances in Noble Metal (Pt, Ru, and Ir)-Based Electrocatalysts for Efficient Hydrogen Evolution Reaction" 5 *ACS Publication* 31-40 (2020).
[62] Prerna Prabhakar, Sanjay Kathuria and TG Srinivasan, "Why is India Struggling With Manufacturing Competitiveness?", *CSEP,* 8 May, 2025, *available at* <Why is India Struggling With Manufacturing Competitiveness? - CSEP> (last visited on 23 Nov 2025).
[63] Joe Brauch, Chris Skangos, *et. al., Manufacturing Cost Analysis for PEM Electrolyzers and Perspectives for Future Cost Reduction,* Hydrogen and Fuel Cell Seminar, (Long Beach, California, U.S., 15 January, 2025), *available at* <Manufacturing Cost Analysis for PEM Electrolyzers and Perspectives for Future Cost Reduction> (last visited on 23 Nov 2025).
[64] Heather M. Barkholtz, Lina Chong, *et.al., Highly Active Non-PGM Catalysts Prepared from Metal Organic Frameworks,* 5 *Catalyst* 955-965 (2015).
[65] Ibid.

THE LEGAL GREY ZONE: RISKS & PRACTICAL STAKEHOLDER IMPLICATIONS

A. REGULATORY VACUUM

India's IP competition interface creates a pronounced regulatory vacuum for sub-component patent pools, particularly which involve iridium and ruthenium catalyst technologies[66] as they sit at the heart of electrolyzer efficiency[67] and localisation efforts under the NGHM.[68] These upstream pools concentrate control over micro-inputs[69] where India has negligible domestic capacity[70] unlike system-level pools in telecom or digital markets.[71] Despite this, neither the Patents Act nor the Competition Act anticipates the structure. The Patents Act does not distinguish between the pooling of a complete technology and the pooling of discrete scientific sub-components, and therefore offers no guidance on membership criteria, information-exchange safeguards, exclusionary licensing behaviour, or collective control of scarce upstream inputs.[72] At the same time, the Competition Act provides no clarity on whether such collaborative licensing by patentees would qualify as horizontal agreements under Section 3(3)[73] or whether they would be immunised under Section 3(5)[74]'s IP exemption as efficiency-enhancing collaborations.

The judicial decisions have further deepened the vacuum as they have restricted the CCI's jurisdiction in patent-licensing disputes. In *Ericsson v. CCI*,[75] the court held that issues relating to patent licensing fall primarily within the domain of the Patents Act, significantly curtailing the CCI's authority to investigate licensing conduct involving standard-essential patents.[76] This

---

[66] Rajni Malhotra Dhingra and Nisha Dhanraj Dewani, *Intellectual Property Rights and Competition Law in India* (Routledge, London, 1st edn., 2024).
[67] Alexandra Becker, "Engineers slash iridium use in electrolyzer catalyst by 80%, boosting path to affordable green hydrogen", *Rice University News and Media Relations*, 13 October, 2025, *available at* <Engineers slash iridium use in electrolyzer catalyst by 80%, boosting path to affordable green hydrogen | Rice News | News and Media Relations | Rice University> (last visited on 23 Nov 2025).
[68] Government of India, "National Green Hydrogen Mission" (Ministry of New and Renewable Energy, 2025).
[69] Supra note 65.
[70] Supra note 61.
[71] Purushothaman KG, "2025 Telecom Trends: Building the Digital Economy of Tomorrow", *KPMG,* 31 January, 2025, *available at* <2025 Telecom Trends: Building the Digital Economy of Tomorrow> (last visited on 23 Nov 2025).
[72] Supra note 65.
[73] Competition Act, 2002 (Act No. 12 of 2003), s. 3 cl.(3).
[74] Competition Act, 2002 (Act No. 12 of 2003), s. 3 cl.(5).
[75] Telefonaktiebolaget LM Ericsson (PUBL) v. Competition Commission of India, 2016 SCC OnLine Del 1951.
[76] Sandeep Kanoi, "CCI Lacks Jurisdiction Over Patent Holder's Actions Under Patents Act: Delhi HC", *Taxguru,* 21 September, 2024, *available at* <https://taxguru.in/corporate-law/cci-lacks-jurisdiction-patent-holders-actions-patents-act-delhi-hc.html> (last visited on 24 Nov 2025).

reasoning again resurfaced in the *Monsanto v. CCI*,[77] where the court again questioned the CCI's jurisdiction,[78] suggesting that disputes over trait value, licensing restrictions, and royalty structures were fundamentally matters of patent law.[79] Although the Supreme Court ('SC') later permitted limited CCI scrutiny,[80] it did not resolve the deeper jurisdictional ambiguity,[81] and the overall effect of these decisions has been to create a regulatory no-man's-land. The CCI's powers to examine licensing conduct are narrow[82] and the Patents Act contains no framework for overseeing patent pools,[83] then upstream sub-component pools operate with virtually no regulatory oversight.

This uncertainty is further compounded by the fact that Indian jurisprudence has never examined collective licensing arrangements for micro-inputs in clean technologies. Even the *Telefonaktiebolaget LM Ericsson v. Lava*,[84] India's longest Standard Essential Patent ('SEP') dispute addressed the bilateral licensing conflicts rather than collaborative patent pooling.[85] Further, the CCI's in *Google LLC v. CCI,* [86] famously known as the *Android decision case,* and *Cartelisation in the supply of Bearings (Automotive and Industrial) In re* (Auto-parts cartel cases)[87] also do not extend to patent pooling or upstream clean-tech components. Courts have acknowledged FRAND as a contractual norm in SEP disputes, but there is no precedent extending FRAND principles to non-SEP or clean-technology settings.

Together, these jurisprudential threads create a legally unregulated space in which sub-component catalyst pools could shape market structure, pricing, and access without meaningful

[77] Monsanto Holdings (P) Ltd. v. CCI, 2020 SCC OnLine Del 598.
[78] Yavipriya Gupta, "Monsanto Decision: Fresh Recourse to Jurisdictional Conflicts in Indian Competition Law?", *CBCL NLIU*, 28 September, 2020, *available at* <Monsanto Decision: Fresh Recourse to Jurisdictional Conflicts in Indian Competition Law? - NLIU CBCL> (last visited on 24 Nov 2025).
[79] Yagya Sharma and Paridhi Rastogi, "Monsanto Judgment: A Step Towards Resolving a Jurisdictional Conundrum", *IRCCL,* 18 June, 2020, *available at* <Monsanto Judgment: A Step Towards Resolving a Jurisdictional Conundrum>(last visited on 24 Nov 2025).
[80] ICAI v. Competition Commission of India, 2023 DHC 4000.
[81] Badal Singh, "Jurisdiction of Competition Commission of India: An authority under perpetual judicial scrutiny", *CBCL NLIU,* 17 July 2023, *available at* <Jurisdiction of Competition Commission of India: An authority under perpetual judicial scrutiny - NLIU CBCL> (last visited on 24 Nov 2025).
[82] Devansh Malhotra and Vaibhav Garg, "CCI Cannot Compel any Statutory Regulator to Outsource its Functions: An Analysis of ICAI v. CCI", *Centre for Research in Competition Law & Policy NLIU, available at* <CCI Cannot Compel any Statutory Regulator to Outsource its Functions: An Analysis of ICAI v. CCI> (last visited on 24 Nov 2025).
[83] Supra note 42.
[84] LAVA International Ltd. v. Telefonaktiebolaget LM Ericsson, 2024 SCC OnLine Del 2497.
[85] Dhruv Mathur and Rima Majumdar, "Ericsson Scores Big Win in FRAND Ruling in Patent Infringement", *S.S. Rana and Co.*, 12 April, 2024, *available at* <Ericsson Scores Big Win in FRAND Ruling in Patent Infringement - S.S. Rana & Co.> (last visited on 24 Nov 2025).
[86] Google LLC v. CCI, 2023 SCC OnLine SC 88.
[87] Cartelisation in the supply of Bearings (Automotive and Industrial), In re, 2021 SCC OnLine CCI 54.

oversight. With India's current domestic catalyst manufacturing capacity in the single-digit percentile range,[88] the absence of clear judicial or statutory guidance leaves a material risk of coordinated royalties, exclusionary membership rules, and foreclosure of non-PGM innovation pathways all occurring in a domain where neither regulator has unquestioned authority.

B. Practical Implications for Stakeholders

The legal vacuum around catalyst-level patent pools becomes particularly consequential as India rapidly scales its green hydrogen ecosystem.[89] By May 2025, the government has already allocated 862,000 tonnes/year of green hydrogen capacity,[90] sanctioned 3,000 MW/year of electrolyzer manufacturing,[91] and committed ₹19,744 crore including ₹17,490 crore under SIGHT within the NGHM.[92] Yet, India still has negligible domestic capability in iridium and ruthenium catalysts,[93] the very inputs that determine electrolyzer efficiency and cost.[94]

For startups, this concentration means that an unregulated patent pool could function as a gatekeeper. The pooling entities may set high royalties or restrictive access terms without FRAND-like obligations or scrutiny under competition law, effectively shutting smaller innovators out of essential catalytic know-how. This could slow the development of indigenous technologies needed for pilot projects in mobility, steel, and shipping such as the hydrogen buses in Leh[95] or the port-based hydrogen production facility at Tuticorin.[96] Electrolyzer OEMs, especially those scaling under the SIGHT manufacturing incentives,[97] face a different kind of uncertainty. With 3,000 MW per year of licensed production capacity planned,[98] manufacturers must lock in long-term catalyst supply. If a sub-component patent pool sets uniform royalties, bundling requirements, or standardised input prices, OEMs may have no ability to negotiate terms independently. This affects the economics of entire downstream ecosystems, from the ₹55.75/kg green ammonia procurement auction for fertilizer units[99] to

[88] Supra note 61.
[89] Supra note 17.
[90] Supra note 7.
[91] Ibid.
[92] Ibid.
[93] Supra note 61.
[94] Supra note 21.
[95] Supra note 8 at 6.
[96] Ibid.
[97] Supra note 8 at 3.
[98] Supra note 8 at 2.
[99] Supra note 8 at 5.

hydrogen fuel trials involving 37 vehicles across 10 routes.[100] A cartel-like pricing effect[101] at the catalyst level could undermine the economics of every mission-linked deployment.

For the government, the vacuum threatens the very viability of localisation policies. India's green hydrogen push is strategically tied to developing national manufacturing capability,[102] including three Green Hydrogen Hubs designated at Deendayal, VOC, and Paradip ports.[103] These hubs are meant to integrate production, consumption, and future export.[104] However, without regulatory oversight over sub-component pools, the cost of electrolyzers which relies heavily on catalyst price and access may remain externally controlled. This could burden public financing, inflate incentives required under SIGHT, and widen the dependence on imported intermediate inputs, contrary to the objective of building a self-reliant value chain.

Researchers and public R&D bodies face subtle but significant distortions. With only ₹400 crore earmarked for R&D under NGHM,[105] Indian labs already operate with constrained resources.[106] If catalyst pools incentivise entrenched precious-metal pathways through coordinated royalty structures, researchers may find it unattractive or financially unfeasible to pursue non-PGM alternatives (such as nickel-based catalysts), despite India having fragmented but existing nickel capacity.[107] This creates a perverse outcome as the upstream pooling behaviour could alter the scientific direction of an entire national mission, pushing it toward legacy technologies, even when alternatives might offer long-term cost and resource security.

Finally, investors and financial institutions must navigate a market where regulatory oversight is limited and judicial precedent leaves it unclear whether the CCI can intervene in licensing practices that resemble horizontal coordination. In a sector where pilot projects now span steel, mobility, shipping, refineries, and fertilizers,[108] investors require predictability in input pricing

[100] Ibid.
[101] Lamiya Jadliwala and Mr Siddharth Tyagi, "Impact of Cartel Activities on Consumer Welfare in India: Price Effects and Market Distortions" 6 *IJIRL* 867-873.
[102] Supra note 8 at 3,5.
[103] Supra note 8 at 3,6.
[104] Ibid.
[105] Supra note 8 at 3.
[106] Supra note 61.
[107] Aruna Sharma, "Why nickel is key to India's clean energy and industrial future", *ET Manufacturing,* 26 September, 2025, *available at* <https://manufacturing.economictimes.indiatimes.com/news/industry/why-nickel-is-key-to-indias-clean-energy-and-industrial-future/124161085> (last visited on 25 Nov 2025).
[108] Government of India, "Launch of Pilot projects in Steel Sector under the National Green Hydrogen Mission" (Ministry of New and Renewable Energy, 2024).

and supply chains.[109] Yet, the legal vacuum around catalyst pools creates uncertainty about whether coordinated pricing or exclusionary licensing could legally persist. This raises due-diligence risks, complicates valuation of electrolyzer OEMs, and may reduce capital flow into early-stage clean-tech ventures.

In sum, India's rapid green hydrogen expansion[110] is built on an upstream input, catalysts, that sits in a regulatory grey zone. Without statutory clarity, pooling behaviour at the sub-component level could shape market access, cost trajectories, and technological pathways across the entire Mission.

COMPARATIVE ANALYSIS

Among global jurisdictions, the EU has developed advanced frameworks for climate-tech licensing,[111] competition oversight in IP-heavy sectors,[112] and hydrogen ecosystem development.[113] The EU's hydrogen centres in Germany, the Netherlands, and Denmark have strong R&D networks[114] and large-scale electrolyzer deployment,[115] making its policy environment particularly instructive. Yet, even with this sophistication, the EU does not have explicit rules for catalyst-level patent pools or other micro-component pools, indicating that the regulatory vacuum India faces is not unique but global.

The EU's competition law architecture grounded in Article 101[116] and Article 102[117] of the Treaty on the Functioning of the European Union ('TFEU') provides structured guidance for evaluating system-level patent pools, such as those in telecom or digital standards. Article

[109] "India: Green hydrogen pilot to cover steel, transport and shipping sectors", *World Ports Org.,* 16 January 2023, *available at* <India: Green hydrogen pilot to cover steel, transport and shipping sectors | World Ports Organization>(last visited on 25 Nov 2025).
[110] Supra note 17.
[111] Kati Kulovesi, Sebastian Oberthür, *et.al.,* "The European Climate Law: Strengthening EU Procedural Climate Governance?" 36 *Journal of Environmental Law* 23-42 (2024).
[112] Lena Hornkohl, Alba Ribera Martínez and Nils Imgarten, "Main Developments in Competition Law and Policy 2024 – European Union", *Kluwers Wolters,* 14 January, 2025, *available at* <Main Developments in Competition Law and Policy 2024 – European Union | Kluwer Competition Law Blog> (last visited on 25 Nov 2025).
[113] European Hydrogen Observatory, "The European hydrogen policy landscape", January 2025, *available at* <The European hydrogen policy landscape- January 2025.pdf> (last visited on 25 Nov 2025).
[114] International Energy Agency, "Northwest European Hydrogen Monitor 2025" (2025).
[115] "Europe's green hydrogen revolution: three promising projects, but also fierce criticism", *Hydrogen Central,* 25 December, 2024, *available at* <Europe's green hydrogen revolution: three promising projects, but also fierce criticism - IOPlus - Hydrogen Central> (last visited on 25 Nov 2025).
[116] Treaty on the Functioning of the European Union, art. 101.
[117] Treaty on the Functioning of the European Union, art. 102.

101(1)[118] prohibits agreements that restrict competition, while Article 101(3)[119] allows exemptions for pro-innovation collaborations. In the case of *Consten & Grundig*,[120] the court established that even IP-licensing agreements are subject to antitrust scrutiny. Further, in the case of *Bayer/Monsanto*,[121] the court reiterated the need to evaluate innovation-market harm. The court built on the scope of unilateral dominance in the case of *Hilti* (Case T-30/89)[122] and *Microsoft* (Case T-201/04),[123] wherein the courts established that how control over essential inputs under Article 102[124] can amount to abusive leveraging which is directly relevant to firms holding upstream catalyst patents for iridium or ruthenium.

The EU Technology Transfer Guidelines, 2022[125] further outline how licensing collaborations should be assessed for anti-competitive conduct. However, these guidelines are explicitly designed for technology-level rather than sub-component-level pooling. As a result, while the EU can evaluate horizontal cooperation among large technology licensors,[126] it cannot directly assess the unique competition risks associated with upstream catalyst pooling, such as control of scarce inputs like iridium and ruthenium.

Moreover, EU hydrogen policy including the EU Hydrogen Strategy, 2020 and the Important Projects of Common European Interest ('IPCEI') focuses on scaling electrolyzer production and incentivising innovation through exemptions under Article 107.[127] However, it doesn't offer a governance framework for managing patent concentration in catalysts. Even Europe's well-established FRAND culture does not extend to climate-critical components. In the case of *Huawei v. ZTE*,[128] the court confined the FRAND condition to the telecom standards and has not been extended to clean-tech or materials-science components, leaving climate-critical sub-component pooling unregulated.

[118] Treaty on the Functioning of the European Union, art. 101 cl.(1).
[119] Treaty on the Functioning of the European Union, art. 101 cl.(3).
[120] *Grundig-Verkaufs-GmbH v Commission of the European Economic Community* (1966) Case 56/64.
[121] Bayer/Monsanto Case M.8084 2018/C 459/10.
[122] *Hilti AG v Commission of the European Communities* (1991) Case T-30/89.
[123] *Microsoft v Commission of the European Communities* (2007) Case T-201/04
[124] Treaty on the Functioning of the European Union, art 102.
[125] EU Technology Transfer Guidelines 2022.
[126] European Union, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements,* 2011/C 11/01 (January 14, 2011).
[127] Treaty on the Functioning of the European Union, art. 107.
[128] *Huawei Technologies Co Ltd v ZTE Corp and ZTE Deutschland GmbH* (2015) Case C-170/13.

Despite these limitations, the EU remains the most favourable comparator for India because it has already recognised the centrality of hydrogen,[129] backed research-intensive clusters,[130] and harmonised competition principles for collaborative innovation.[131] India can therefore borrow the structural discipline of the EU model like clear licensing guidelines, robust competition review, and innovation-linked exemptions while going a step further by explicitly regulating sub-component pools. In effect, the EU provides a strong procedural foundation, but India has the opportunity to lead substantively by crafting the world's first clean-tech sub-component pooling framework tailored to catalyst markets.

WAY FORWARD

A. ESTABLISH A 'CLEAN-TECH SUB-COMPONENT POOLING CODE

India can lead globally by establishing a specific code for sub-component pools tailored to catalysts and upstream materials aligning with the SDG-7[132] and Agenda 21's call for technology cooperation.[133] Under the code, the full disclosure of iridium and ruthenium loading, IP ownership, and efficiency benchmarks will be required. Further, this will be supervised by an independent pool manager or administrator to prevent OEM-driven dominance. This is essential as in 2023, over 95% of commercial PEM catalysts globally, came from fewer than six OEMs,[134] making India especially vulnerable to concentration-led price-setting. Without governance, such concentration risks undermining India's COP-26 and COP-28 commitments to scale green hydrogen responsibly.[135]

B. INTRODUCE FRAND-INSPIRED LICENSING NORMS FOR CATALYST PATENTS

Drawing from COP-21 (Paris Agreement) principles on technology accessibility and capacity-building,[136] India can move beyond voluntary best practices and amend NGHM guidelines to

[129] Supra note 112.
[130] Supra note 113.
[131] Supra note 111.
[132] Supra note 5.
[133] Mohd Shaaz Peerbaksh, "AGENDA-21: Everything You Need to Know About Agenda 21", *B&B Associates LLP, available at* <AGENDA-21: Everything You Need To Know About Agenda 21>(last visited on 25 Nov 2025).
[134] Raksha Sharma, "PEM Fuel Cell Catalysts Market Outlook", *Data Intelo, available at* <Pem Fuel Cell Catalysts Market Report | Global Forecast From 2025 To 2033> (last visited on 25 Nov 2025).
[135] United Nations Climate Change, "Summary of Global Climate Action at COP 28", *available at* < Summary_GCA_COP28.pdf>(last visited on 25 Nov 2025).
[136] United Nations Climate Change, "Key aspects of the Paris Agreement", *available at* < Key aspects of the Paris Agreement | UNFCCC > (last visited on 25 Nov 2025).

insert FRAND-inspired licensing norms for essential catalyst patents. This would include preventing exclusionary licensing, ensuring MSME access, and limiting royalty-stacking that increases PEM stack cost by 12-15%.[137] It matters for India as India's domestic catalyst manufacturing meets only 3-5% of projected 2030 demand,[138] threatening SDG-9 (industry & innovation) unless licensing becomes equitable. This would resolve the ambiguity in Section 3(3)[139] vs. 3(5)[140] by providing a statutory test to determine when IP licensing has anti-competitive effects.

C. MANDATE EX-ANTE COMPETITION REVIEW FOR CATALYST POOLS

To address the jurisdictional grey zone created by *Ericsson*[141] and *Monsanto*,[142] where CCI's power is uncertain and patent pools currently escape scrutiny, India should introduce a fast-track ex-ante CCI review mechanism under Sections 19[143] and 49[144] of the Competition Act specifically for sub-component pools. Echoing the UNFCCC's emphasis on transparency in climate-critical technologies[145] and borrowing from merger-notification logic, any proposed pooling arrangement that crosses a defined concentration threshold such as control over more than 25% of global catalyst patents, should undergo pre-clearance. This review would require disclosure of pricing algorithms, royalty structures, efficiency-data sharing, and governance rules, preventing covert coordination or collective dominance. The need for ex-ante review is crucial as the top five patent families already account for ~40% of global PEM catalyst filings,[146] creating a structural risk of price alignment and market foreclosure that directly undermines India's COP-27 commitments to "*just and equitable energy transitions*".[147]

---

[137] Supra note 113, 133.
[138] Market Research Reports, "India Catalysts Market Research Report: Forecast (2025-2030)", *MarkNtel,* September 2025, *available at* <India Catalysts Market: Size, Trends & Growth Insights to 2030> (last visited on 25 Nov 2025).
[139] Competition Act, 2002 (Act No. 12 of 2003), s. 3 cl.(3).
[140] Competition Act, 2002 (Act No. 12 of 2003), s. 3 cl.(5).
[141] Telefonaktiebolaget LM Ericsson (PUBL) v. Competition Commission of India, 2016 SCC OnLine Del 1951; Telefonaktiebolaget LM Ericsson (PUBL) v. Competition Commission of India, 2015 SCC OnLine Del 14689.
[142] Monsanto Holdings (P) Ltd. v. CCI, 2020 SCC OnLine Del 598.
[143] Competition Act, 2002 (Act No. 12 of 2003), s. 19.
[144] Competition Act, 2002 (Act No. 12 of 2003), s. 49.
[145] United Nations Climate Change, "Together4Transparency: Driving Progress to Meet Climate Goals", *UNFCCC,* 9 July 2025, *available at* <#Together4Transparency: Driving Progress to Meet Climate Goals | UNFCCC> (last visited on 25 Nov 2025).
[146] WIPO, "Patent and Utility Models", 2023, *available at* <IP Facts and Figures 2024 - Patents and utility models> (last visited on 25 Nov 2025).
[147] Government of India, "COP 27 and ensuring climate justice" (Ministry of Environment, Forest and Climate Change, 2022).

D. Build Public Pre-Competitive R&D Networks to Break OEM Dependence

To prevent the distortion of R&D caused by monopolised catalyst pools, India should built a public pre-competitive Catalyst Materials Innovation Hubs ('MNRE') and DBT-funded public-private R&D clusters by linking CSIR labs, IITs, NGHM clusters, and private innovators focused on non-PGM catalyst innovation which global studies suggest could reduce PEM electrolyzer costs by up to 70%,[148] shared testing facilities, and open pilot-scale experimentation. These networks should be linked to SDG 7,[149] SDG 9, and Agenda 21's emphasis on clean technology diffusion.[150] Hence, this will reduce India's dependence on foreign upstream patents ensuring that Indian researchers are not pushed toward costlier precious-metal pathways simply because upstream licensing is restrictive.

E. Build an Open Catalyst Performance & IP Database

The information asymmetry that allows patent pools or OEMs to leverage proprietary testing metrics to dominate pricing and restrict market entry stands as a major challenge for the startups and domestic OEMs scaling under the 3,000 MW electrolyzer capacity allocation.[151] In order to address this, India should create a public, government-verified datasets "*Catalyst Data Commons*" in line with COP-28's call for open climate-relevant data and technology transfer,[152] that publishes the catalyst durability metrics, degradation cycles, iridium/ruthenium loading, and efficiency curves.

F. Create 'Royalty-Buydown' Mechanisms for High-Impact Catalyst Patents

To prevent the catalyst-level pricing from becoming a bottleneck that undermines mission deployment economics, India could establish a sovereign or multilateral buydown fund that subsidises royalty payments for public-benefit catalysts inspired by mechanisms used in public-health AMCs and endorsed in climate-finance dialogues at COP-29.[153] Catalyst royalties constitute around 8-10% of stack-level cost[154] and the buydown funds can unlock wider adoption while supporting SDG-7[155] and the Paris Agreement's technology

[148] Supra note 133.
[149] Supra note 5.
[150] Supra note 132.
[151] Supra note 12.
[152] Supra note 134.
[153] World Health Organisation, "At COP29, WHO calls for climate-health actions and funding for Asia Pacific", 16 November 2024, *available at* < At COP29, WHO calls for climate-health actions and funding for Asia Pacific> (last visited on 25 Nov 2025).
[154] Supra note 21.
[155] Supra note 5.

provisions.[156] The early deployments of green mobility pilots, port hydrogen initiatives, refinery transition will become more viable with the adoption of this mechanism.

G. Link Patent Pool Participation to ESG & Critical Mineral Transparency

To pre-empt geopolitical and environmental risk in localisation efforts, India should require the full disclosure of PGM sourcing, extraction sustainability, and geopolitical dependencies, independent audits aligned with COP-28's mineral governance dialogue[157] and ensure that pooling does not conceal unethical or fragile supply chains under the India's emerging Critical Minerals Mission.[158] Given that demand for iridium is projected to rise 4-7 times by 2030,[159] it is necessary to trace the origin, movement, and sustainability profile of every upstream PGM input to ensure that India's hydrogen value chain does not become structurally dependent on opaque, high-risk, or environmentally unsustainable supply routes.

CONCLUSION

A structured, phased implementation strategy is required to implement the core recommendations that integrates competition law, mission governance, environmental commitments, and India's broader hydrogen industrial policy. The recommendations proposed above can be operationalised through a three-phase mechanism that gradually builds regulatory certainty while safeguarding innovation incentives.

A. Phase I (0–18 months): Foundational Governance & Transparency

The first phase should focus on establishing the institutional and regulatory scaffolding issuing the Clean-Tech Sub-Component Pooling Code, initiating FRAND-inspired licensing norms within NGHM guidelines, and creating the Catalyst Data Commons. Simultaneously, CCI, DPIIT, and MNRE should constitute the tri-agency Monitoring Cell to consolidate market intelligence on PGM sourcing, patent aggregation trends, and catalyst pricing. These early steps carry modest administrative costs and will generate immediate benefits by reducing

[156] Supra note 135.
[157] United Nations News, "COP28: Extraction of minerals needed for green energy must be 'sustainable and just', says Guterres | UN News", 2 December 2023, *available at* < COP28: Extraction of minerals needed for green energy must be 'sustainable and just', says Guterres | UN News > (last visited on 25 Nov 2025).
[158] "India's Critical Mineral Mission: Securing the Minerals of Tomorrow", *PIB GoI,* 6 September, 2025, *available at* < doc202596629501.pdf> (last visited on 25 Nov 2025).
[159] Supra note 137.

information asymmetry, lowering compliance ambiguity, and improving investor confidence across early-stage hydrogen deployments.

B. Phase II (18–36 months): Market Regulation & Competition Alignment

The second phase should operationalise ex-ante competition review for sub-component pools, implement localisation-linked conditions for SIGHT incentives, and mandate critical mineral transparency for all pool participants. This will align the regulatory practice with India's commitments under COP-26, COP-27, and Agenda 21. While compliance costs may rise marginally for foreign OEMs and patent holders, the benefits, that is, fairer access for MSMEs, diversified domestic research trajectories, and reduced risk of coordinated pricing substantially outweigh the transitional burden. This phase will also enable India to buffer its electrolyzer manufacturing sector from global supply shocks in iridium and ruthenium, particularly as projected iridium demand rises 4-7× by 2030.[160]

C. Phase III (36–60 months): Global Norm-Setting & Catalytic Innovation Incentives

The final phase involves positioning India as a global norm-setter by championing sub-component pool governance frameworks at G20, ICAO, and COP platforms, and operationalising sovereign "royalty-buydown" funds for public-benefit catalyst patents. This will also coincide with India's scaling of its Green Hydrogen Hubs at Deendayal, VOC, and Paradip.[161] Although establishing buydown mechanisms requires targeted fiscal commitment, their cost is marginal when weighed against the benefits of lower catalyst royalties (8–10% of stack cost),[162] accelerated deployment of green hydrogen projects, reduced import dependence, and fulfilment of SDG 7 and SDG 13 goals. The long-term gains also include enhanced domestic manufacturing competitiveness and new export diplomacy opportunities in electrolyzer technologies.

D. What Lies Ahead

While the implementation mechanism can require a moderate regulatory and administrative expenditure for monitoring and ex-ante review mechanisms, limited compliance burden for pool participants (transparency and FRAND obligations) and targeted fiscal outlay for royalty-

[160] Ibid.
[161] Supra note 102.
[162] Supra note 21.

buydown mechanisms, the benefits are substantial. The mechanism aims to prevent cartelisation and royalty stacking in high-risk upstream inputs and foster stronger localisation outcomes for ₹19,744 crore NGHM investments.[163] Further, the increased innovation diversity and reduced dependence on 5-6 global OEMs controlling 95% of PEM catalyst supply[164] will enable India to built a more self-reliant and shock-absorbing hydrogen ecosystem, that is resilient to PGM supply volatility as iridium and ruthenium become globally contested critical minerals, and firmly aligned with SDGs, Agenda 21, and COP commitments, thereby strengthening India's long-term hydrogen diplomacy and clean-tech leadership.

Thus, India can transform the current regulatory vacuum into a strategic advantage, creating the world's first comprehensive governance architecture for clean-tech sub-component pools. This will support the NGHM's industrial goals and safeguard innovation ecosystems, reducing the systemic risks from catalyst concentration, and position India as a global rule-maker in climate-critical technologies.

[163] Supra note 7.
[164] Supra note 133.