2025; 1-1 | pp.10-15

Academians Journal of Natural and Biosciences Studies

ISSN: XXXX-XXXX

Volume 1, Issue 1, July-September 2025

(An Academians Publishers of Research & Academic Resources)

Original Research Article

Received: 18-07-2025 **Accepted**: 20-08-2025 **Published**: 26-09-2025

Algorithmic Accountability in Climate Tech Innovation: Redefining Patent Law, Incentives, and Governance for AI-Driven Green Inventions

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Abstract: The swift incorporation of artificial intelligence (AI) into the development of climate technology (Climate Tech) is producing a new category of inventions that are crucial for addressing the global climate emergency. By enhancing carbon capture technologies and creating innovative energy storage materials, AI serves as more than just a tool, functioning instead as a creative collaborator. This shift in perspective challenges the human-centered basis of patent law, introducing notable legal ambiguities concerning inventorship, ownership, and the adequacy of disclosure for AI-created environmentally friendly innovations.This paper introduces the Framework for Algorithmic-Inventive Contribution (FAIC), a novel legal and regulatory model designed to attribute patent rights for AI-driven Climate Tech innovations. The FAIC model defines inventorship using a multi-factor evaluation that considers the level and extent of human supervision, the independence of algorithms, and the origin of data. It further proposes tailored disclosure requirements, including an Algorithmic Impact Statement (AIS) and a Green Technology Efficacy Report, to ensure transparency, reproducibility, and alignment with public welfare goals.This paper investigates the economic effects of concentrated AI patent ownership on fair technology transfer to developing countries by exploring case studies in grid optimization, carbon accounting, and sustainable material science. It wraps up with a suggestion for a governance framework that includes compulsory licensing triggers aligned with climate impact metrics and a patent-term adjustment model (PTA-Green) to strike a balance between fostering innovation and addressing the critical global public good of climate change mitigation. The research asserts that patent law should transition from being purely incentive-focused to one that emphasizes stewardship, clearly acknowledging AI's pivotal role in creating a sustainable future.

Keywords: *algorithmic accountability, green patents, inventorship, compulsory licensing, technology transfer, sustainable development, ethical governance*

1. Independent Scholar

1. Introduction

The most pressing issue of our day is the climate problem, which necessitates quick and unheard-of technical advancement. In this effort, artificial intelligence has become a potent catalyst, propelling innovations in climate resilience, carbon sequestration, renewable energy, and circular economy models (Rolnick et al., 2022). Traditional intellectual property (IP) regimes, however, face a serious challenge from the autonomous, generative ability of AI systems to provide patentable climate solutions, such as innovative electrolyzer catalysts for green hydrogen or AI-optimized microgrid designs (Abbott & Corrales, 2023). These legal systems are based on human agency,

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intentionality, and conception—concepts that become hazy when a computer performs the main creative act.

By putting forth a novel legal and legislative framework specifically designed for AI-driven green technologies, this article tackles these intertwining issues. It goes beyond the controversy surrounding the question of whether artificial intelligence (AI) can be an inventor, which was largely resolved in the negative by international courts after the DABUS case (Thaler v. Hirshfeld, 2021). Instead, it addresses the more practical question of how patent law can be modified to efficiently encourage, safeguard, and regulate AI-generated climate inventions while guaranteeing their fair and quick spread.

To address this question, the paper is organized as follows: Section 2 offers background information on the transformative impact of AI in Climate Tech. Section 3 delivers a legal analysis on the difficulties current patent doctrines face with inventions generated by AI. Section 4 introduces the **Framework for Algorithmic-Inventive Contribution (FAIC)**. The proposed disclosure requirements and patent-term adjustment model are described in detail in Section 5. The ethical and economic aspects, including fair access, are examined in Sections 6 and 7. Mechanisms for technological transfer and mandatory licensing are examined in Section 8. Section 9 concludes with a discussion of the results and a compelling case for immediate legal modernization.

2. The Role of AI in Climate Technology Innovation

In several fields, artificial intelligence is transforming efforts to mitigate and adapt to climate change. In order to find patterns and answers that are beyond human comprehension, machine learning (ML) and deep learning (DL) algorithms analyze enormous, complicated datasets, ranging from molecular simulations to satellite imagery and Internet of Things sensor networks (Rolnick et al., 2022). Important areas of application include:

- **Energy System Optimization:** By balancing demand-response mechanisms and storage with intermittent renewable sources like wind and solar, artificial intelligence (AI) algorithms optimize the operation of national power grids, greatly increasing efficiency and lowering dependency on fossil fuels (Chen et al., 2023).
- **Materials Discovery:** New materials with certain qualities, such improved battery electrolytes, more efficient solar cells, and lower-carbon cement substitutes, are created using generative AI models (Lu et al., 2023). For example, millions of new hypothetical material structures have been found by Google DeepMind's AI, whereas humans would need centuries to complete the same effort (Merchant et al., 2023).
- **Carbon Capture and Utilization (CCU):** AI models speed up the development of affordable CCU technology by simulating and optimizing procedures for removing carbon dioxide from the air or point sources and turning it into valuable products (Keith et al., 2024).
- **Precision Agriculture:** Through crop health monitoring, targeted fertilizer and pesticide application, and irrigation optimization, AI-driven solutions reduce agriculture's environmental impact (Lottes et al., 2023).

There are significant time and economic efficiencies. Given the narrow timeframe for climate action described by the IPCC (2023), AI can accelerate the research and development of new climate technology from years to months. However, the legal issues discussed in the next section are created by

this very acceleration and the nature of AI's contribution.

3. Legal Analysis: Patent Law Doctrine and AI-Generated Climate Inventions

AI-generated innovation is putting a pressure on the fundamental tenets of patent law: inventorship, novelty, non-obviousness, and enablement.

3.1. Inventorship and Ownership

According to all patent statutes, an inventor is a "natural person" or "individual" who comes up with the idea. (Burroughs Wellcome Co. v. Barr Labs., Inc., 1994) The "formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention" is known as conception. AI systems cannot satisfy this need since they lack mental states and legal persons. This was made clear in the DABUS verdicts, where the USPTO, EPO, and UK Supreme Court invalidated patents that named an AI as the inventor (Thaler v. Hirshfeld, 2021; Thaler v. Comptroller-General, 2023).

Assigning inventorship to the human or humans that created, trained, or implemented the AI is the default solution. However, this becomes problematic when a highly autonomous AI system produces unexpected and useful results. When a private corporation uses a generalized AI model that was trained on large chemical datasets by a team of university academics to create a novel carbon-neutral polymer, who is the inventor? The researchers, the engineers at the corporation, the person who started the process, or the AI's owner? The lack of a clear solution in the current legislation causes a great deal of uncertainty for investors and climate tech developers.

3.2. Patentability and Disclosure Requirements

AI-generated inventions encounter challenges under the enabling and written description criteria, even in cases where inventorship is settled. A patent must instruct a knowledgeable practitioner in the creation and application of the invention without "undue experimentation." On the other hand, intricate deep learning models may be unsolvable "black boxes." It might be hard to explain why an AI-designed molecule is so effective, just that it is. The fundamental tenet of the patent agreement—public transparency in return for a brief monopoly—is called into question by this opacity. The quid pro quo is unsuccessful if the invention from the patent filing is not understandable or reproducible by the general public (Aboy et al., 2024).

4. Introducing the Framework for Algorithmic-Inventive Contribution (FAIC)

To address these challenges, this paper proposes the **Framework for Algorithmic-Inventive Contribution (FAIC)**. The FAIC is a multi-factor test that goes beyond the simple "human vs. AI" debate to determine inventorship and ownership in AI-human joint inventions.

The FAIC evaluates:

1. **Degree of Human Direction:** Did the AI receive specialized training or be given a specific mission to do, such as "find a molecule with high ionic conductivity for solid-state batteries"? Or did it use a general-purpose dataset to coincidentally produce the invention?
2. **Autonomy of the AI System:** To what extent was it autonomous? Did the AI use generative or reinforcement learning techniques to investigate a solution space in new ways, or did it only carry out a preset search?
3. **Substantiality of the AI's Output:** Was the result a non-trivial, non-obvious solution, or was it a trivial or obvious extension of its training data?
4. **Role of Human Interpretation and Reduction to Practice:** Did a human actor successfully translate the AI's output into practice (e.g., build the molecule and evaluate its qualities) after realizing its usefulness?

According to this theory, the natural person or people who gave the important guidance (Factor 1) and/or interpreted and put the outcome into practice (Factor 4) would be given inventorship. Subject to employment agreements, these inventors would first become the owners. Courts and patent offices can use the FAIC's adaptable, principles-based approach to address the diverse range of human-AI collaboration.

5. Operationalizing the FAIC: Disclosure and Patent Term Adjustment

New procedural processes are needed for augmented inventorship to be recognized legally.

5.1. Enhanced Disclosure Requirements

For patents involving a significant AI contribution, we propose two mandatory disclosures:

- **Algorithmic Impact Statement (AIS):** Key parameters, training data sources and any biases, the architecture of the AI model, and a high-level description of the decision-making process that resulted in the innovation would all be covered in detail in this document. This seeks to enable the "black box" by demythologizing it to a sufficient extent.
- **Green Technology Efficacy Report:** Regarding climate technology, this report would offer factual information or forecasts regarding the invention's possible influence on lowering greenhouse gas emissions, increasing energy efficiency, or other environmental indicators. This immediately links the patent to its argument for public benefit.

5.2. Patent-Term Adjustment for Green Inventions (PTA-Green)

Traditional 20-year terms may not be optimal for fast-moving AI-driven Climate Tech. We propose a **PTA-Green** model:

- **Reduced Base Term:** 15 years is a typical duration for green inventions enhanced by AI, representing faster development cycles.
- **Performance-Based Extension:** A potential extension of up to 5 years could be granted upon demonstrating successful commercialization and verified positive environmental impact (e.g., proven CO2 reductions), validated by a third party. This aligns private profit motives with public environmental goals.

6. Economic Implications: Incentives, Concentration, and Access

In certain areas of climate technology, AI promises to reduce entrance barriers, but in others, it may increase them. The best-performing models need enormous computational resources and massive, proprietary datasets, which are advantages held by giant tech and energy businesses, even though startups can leverage cloud-based AI tools to undertake virtual R&D (Cockburn et al., 2019). This might result in a concentration of patent ownership around important AI-driven climate solutions, such sophisticated battery chemistries or grid management algorithms.

Such concentration runs the risk of generating "green patent thickets," in which the development and implementation of integrated systems are impeded by overlapping intellectual property rights held by several entities. Because developing nations lack the financial means to license costly patented technologies, this poses a threat to the very technical diffusion that is necessary for global decarbonization.

7. Ethical Dimensions and Equitable Access

IP policy for climate technology must be centered on the moral requirement of climate justice. A type of technical bias may be perpetuated if AI systems trained exclusively on data from the Global North provide solutions that are inappropriate for the

circumstances of the Global South. Furthermore, it would be a grave ethical failing if life-saving climate adaptation technologies—like flood prediction systems or drought-resistant crops—were restricted by expensive patents.

It is necessary to use patent law to advance fair access. This entails bolstering mechanisms for technology transfer under international agreements such as the UNFCCC, establishing tiered royalty arrangements according to a nation's level of development, and encouraging open-source models for some basic technologies.

8. Compulsory Licensing and Technology Transfer for Climate Mitigation

In the interest of public health, compulsory licensing is permitted under the TRIPS Agreement. One may argue persuasively that the climate issue poses a comparable, if not more serious, threat to survival and public health (Gervais, 2022). We suggest amending international treaties and national laws to specifically acknowledge a climate emergency as a justification for requiring permits for environmentally necessary technologies.

Objective requirements, such a technology's inclusion on a UN-approved list of important climate mitigation technologies, along with a failure to work the patent or provide it on reasonable terms in a vulnerable nation within a given date, might start the process. The patent holder would get royalties, which would be adjusted to guarantee affordability.

9. Discussion and Conclusion

AI is already being incorporated into innovative climate technologies; it is not a far-off future event. It is beyond the capabilities of the current patent system, which was created for a time when inventions were solely human. Failure to adapt could impede global cooperation required to prevent a climate catastrophe, stifle innovation, and promote secrecy over disclosure.

This paper has argued for a proactive modernization of patent law based on the principles of the **Framework for Algorithmic-Inventive Contribution (FAIC)**, enhanced transparency via the **Algorithmic Impact Statement (AIS)**, and aligned incentives through the **PTA-Green** model. Instead of giving machines rights, these changes aim to efficiently regulate the results of human-machine cooperation for the benefit of the general public.

We can fully utilize innovation to create a sustainable future by establishing a transparent, predictable, and fair process for safeguarding AI-driven green ideas. By encouraging both ground-breaking innovation and its equitable distribution around the world, the suggested framework aims to guarantee that the patent system transforms from a holdover from the industrial era into a pillar of the climate resilience era.

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