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Clean and sustainable technology innovation

Tabrez Y Ebrahim

Has patent law provided adequate incentives for environmental innovation? This Article provides a narrative review that describes (1) clean and sustainable technological inventions and (2) various environmental innovation approaches involving patents in some form and incentivizing technological development and diffusion. Clean, sustainable, or green inventions that lower pollution, use resources in a more sustainable manner, recycle more of their wastes and products, or provide significant energy efficiency have garnered an incredible amount of attention. Scholars and other commentators have analysed the role of patents in facilitating technological development to mitigate climate change, including eco-patent commons, a fast track program, a patent rewards system, and a collaborative and cooperative platform. An analysis of the literature shows that patent law offers certain, though perhaps underutilized, opportunities to promote technological innovation that has environmental benefits.

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Introduction

Recent advances in technology have resulted in numerous discussions among legal scholars as how the law relates to clean and sustainable technology innovation. At its core, clean and sustainable technology prevents environmental harm, provides environmental improvements, or embraces environmental consciousness [1–4]. As society seeks to become more enhanced with technology designed to repair, improve, or prevent damage to the environment, what innovation mechanisms can incentivize technological development?

To meet the challenges posed by climate change, technological innovations are needed that address

environmental problems. Businesses and governments have embarked on initiatives to develop clean technology and sustainability solutions in recent years. Legal scholars and economists have studied a variety of innovation mechanisms, including patents, prizes, grants, and tax credits, among others [5–13]. Patents have been considered as effective inducements to innovative activity, since they can incentivize innovation by allowing patent owners to exclude those who may free-ride on their investments [14]. Economic theory suggests that patents are a policy instrument to foster innovation and diffusion of technology [15]. Environmental legislation and regulation in isolation have failed to provide adequate incentives for technological development to address climate change. A narrative review of the literature suggests that patent law proposals — including eco-patent commons [16**], a fast track program [17], a patent rewards system [18*], and a collaborative and cooperative platform [19**] — have provided varied incentives and results for environmental innovation.

An exploration of whether patent law can step in where environmental law has failed to efficiently provide incentives for environmental innovation impacts the development of a variety of clean and sustainable technologies. Based on a literature review and legal analysis, the main goal of this Article is to provide a timely narrative review and synthesis of papers concerning clean and sustainable technologies and various patent related innovation proposals. It adopts a semi-systematic review of law and policy papers to identify and understand potentially relevant views of patents on inducing environmental innovation. In so doing, this methodology tracks law and policy perspectives to identify a common theme concerning recent developments and new innovations in this literature, including through an assessment of recent references. Such a semi-systematic review approach as a research methodology presents various patent-related mechanisms for clean and sustainable innovation, in order to provide insights and guidance for intervention into environmental innovation. This Article closes with normative implications that assess and reflect upon recent developments in environmental innovation.

Clean and sustainable technologies

There are no standards definitions to clean technology or to sustainable technology, but they both strive to improve the environment or reduce environmental damage. These technologies have been referred to as being alternate energy, cleantech, green, and/or sustainable; while different terminology is utilized, each refers to innovative technological solutions for environmental issues.

In general, clean technology has been defined by the United Nations as energy-generating technologies that have the potential for reducing greenhouse gases [20]. Clean technology refers to measures taken to reduce or eliminate at the source of production any nuisance, pollution, or waste, and to help save raw materials, natural resources, and energy, thereby increasing performance, productivity, or efficiency by minimizing negative effects on the environment [21,22]. Sustainable technology refers to the design of chemical products that offer environmentally friendly alternatives; these sustainable technologies can either prevent waste, are less toxic, use renewable feedstock, use safer solvents and reaction conditions, or increase energy efficiency [23]. The terms 'cleantech' and 'sustainability technology' were born around the year 2000 and refer to a wide range of environmental technologies and processes, including renewable energy, nanotechnologies, energy efficiency and storage, materials, and improvements to industrial processes [24].

Approaches to incentivize environmental innovation

Governments have intervened in the marketplace of clean and sustainable technology in order to induce change necessary for socially beneficial research and development to extract value with environmental impact. Patents provide one legal policy mechanism to affect market behaviour since they give their owners the right to exclude others from practicing a patented technology or charge a license fee for the right to do so. Various other proposals have been suggested for increasing innovation and diffusion of clean and sustainable technologies aimed at addressing climate change [25]. Some of these strategies increase the number of patents in this sector with the aim of encouraging private sector investment and other strategies decrease the potency of patents in order to reduce exclusionary behaviors and increase competition among firms [26].

Eco-patent commons

An increasing number of firms across different industries have pledged to limit their ability to enforce patents in order to promote the advocacy of new technology and to pursue societal goals, such as those focused on the environment [27**]. The pledge of patents for the public good aims to pool patents, such that use of patents for traditional exclusionary purposes is curtailed. Under this approach, patent assets are retained by their owners and benefits are conferred to all third parties (not necessarily the participating contributors) in order to promote collaboration between businesses and accelerate innovation [28**]. It is a private ordering approach to incentivizing the dissemination of clean and sustainable technologies.

Eco-patent commons refers to a not-for-profit initiative established in January 2008 by several large multinational

companies to provide royalty-free access to 248 patents covering 94 clean and sustainable inventions, with the aim of encouraging their diffusion [29]. The patents within the eco-patent commons were situated within a searchable website and were open to all, with global participation by businesses in diverse industries and provided benefits to its participations (such as an opportunity to present an environmentally friendly public relations agenda, promoting a catalyst for further innovation, facilitating business collaboration, and encouraging cooperation and collaboration between businesses) [30]. Eco-patent commons generated substantial attention, and they enabled its participating patent owners to make their patents freely available to other parties, including competitors, while the patent owners paid the costs of maintaining the rights to the patents. An in-depth study concerning the effect of eco-patent commons on clean and sustainable technology diffusion revealed that it did not increase the diffusion of pledged patents, found that such patents are less cited (than control matched patents) before they enter the commons, and shown greater lapses in patent maintenance (such as more patent expiration, rejection or withdrawal, or nonpayment of renewal fees) [31**]. Thus, eco-patent commons seems to suggest that participating companies did not consider the benefits of a commons relative to the costs, were not easy for users to benefit and difficult to track utilization, and needed a larger number of participating companies to garner an appropriate pay-off.

Fast track program

Governments have recognized the importance of development of clean and sustainable technologies, and have looked at accelerating patenting procedures to expedite examination of patent application directed to such technologies [32,33]. These procedures reduce the time necessary for inventors to obtain patents on clean and sustainable technologies. Various patent offices around the world have introduced programs that expedite patenting of such inventions, but vary widely in their requirements. For example, the U.S. government has created programs to encourage inventors to file clean and sustainable technology patents that quicken the pace of the patent system and to the marketplace [34*].

The United States Patent & Trademark Office (USPTO) had started a Green Technology Pilot Program in 2009 to accelerate the development and deployment of clean and sustainable technologies by affording such technologies with a special status for expedited examination [35]. The USPTO expanded the Green Technology Pilot Program in 2010 to more categories to be eligible for expedited processing under the program, and several hundred requests were granted for such accelerated examination [36]. At the completion of one year, a total of 790 petitions for accelerated examination were granted and 94 patents had been issued by the end of 2010, and the program's

statistics showed that those who used the pilot program obtain a patent much quicker than with standardized patent examination [37]. After 2 years of this pilot program, more than 2500 petitions for accelerated examination were granted and more than 500 patents had been issued by the end of 2010 for technologies involving reduced greenhouse gas emissions and energy conservation and environmental quality [38]. However, by March 30, 2012, or the date that 35 000 patent applications has been special status under the pilot program, the USPTO announced the closure of the program for petitions to make special and accelerate clean and sustainable technology patent applications [39].

Scholars have recognized the role that fast track program of expediting innovation of clean and sustainable technologies, and have proposed that such programs be harmonized and maximize eligibility across jurisdictions in order to make participation easier and more efficient [40^{*}]. Harmonization would provide a single, standardized set of rules to apply to each national patent office, and obviate the comply with several different iterations and reduce the burden on applicants, particularly those with international reach across multiple jurisdictions.

Patent rewards system

The underlying principle for advocating a patent rewards system for clean and sustainable technologies is that a cleaner environment constitutes a public good (meaning, one individual's use does not reduce another's use), and that positive externalities undercut demand for environmentally friendly products and services [41]. In other words, profit-maximizing firms do not subscribe much weight to the environmental benefit of a technological investment towards the social value and benefit on numerous third parties and to society, but instead are focused on the direct costs. Thus, if businesses are not willing to pay for clean and sustainable technologies that reflect their social value, then the patent system may not incentivize development of such technologies to a socially optimal value.

Instead, an alternative type patent system — a patent rewards system — could bring private incentives in line with the social value of an invention, and could be woven into the existing patent system [18^{*}]. Similar to inventions concerning national security, which may not receive patents, a patent reward system would provide a monetary reward based on the importance of the invention. While valuing the environmental benefit may be difficult, it already exists in some administrative agencies. In effect, such a rewards proposal is akin to a prize, where an inventor is paid an amount in the form of prize and the invention is then placed into the public domain, and then the invention is placed into the public domain [42]. While a patent rewards proposal for clean and sustainable technologies would allow the government to acquire rights to

patent, compensate the inventor directly, and would enable the government to force licensing of the invention or use the invention itself, it would generate a significant shift from the current patent regime [18^{*}]. A patent rewards system has not been implemented by any country and generated mostly scholarly debate.

Collaborative and cooperative platform

In addition to the aforementioned proposals — where one implemented proposals decreases the strength of patents (such as eco-patent commons), one implemented proposal increases the strength of patents (such as fast track patent application programs), and another yet to be implement proposal may have mixed or unclear results (a patent rewards system) — another proposal would operate internationally in collaborative and cooperative platform to make clean and sustainable technologies more freely available. This approach would provide mutually beneficial international cooperation, in which organizations and countries would work together to develop and deploy clean and sustainable technologies on mutually agreeable terms through a neutral and independent entity that ensures that organizations and countries are clear of ownership and sharing of patents involved or created during the cooperation [19^{*}].

The World Intellectual Property Organization (WIPO) has developed a WIPO Green Program, which acts as an intermediary and online marketplace between providers and users of clean and sustainable technologies but does not inform users about well-informed and mutually beneficial deployment transactions [43]. This collaborative and cooperative platform proposal would enhance the WIPO Green Program by allowing greater discussion and access among participants, increase motivation for fair dealings, and balance disparities between developing and developed countries through subsidies enabled by the enhanced platform. In effect, this proposal would enrich WIPO's efforts, which stipulates all participating countries to promote and cooperating with developing and diffusing clean and sustainable technology and encourage enabling developing countries to pursue their objectives in a climate friendly way [44].

Opportunities, challenges, and implications

There is need and correspondingly an opportunity for the development and dissemination of clean and sustainable technologies in response to climate change, so much so that human survival depends on improvement and dissemination of technology [45,46]. Representative promising recent and innovative clean and sustainable technologies include energy storage, light emitting diodes, solar power, and carbon capture and storage [47]. The cost of clean and sustainable adaptation, deployment, and climate change mitigation will depend on whether these technologies are patented, licensed, or shared in a pool, and on what technological substitutes are affordably available [48^{*}].

A major challenge to achieving goals for clean and sustainable technology development and deployment is determining whether private markets or patenting or shared resources will be utilized to effectuate clean and sustainable development. Such a decision places stress on domestic and international policymakers concerning the scope of the patent system, and a related challenge is defining the circumstances under which clean sustainable technologies should be freely accessible or propertized.

In critically assessing the challenges, the assessment of clean and sustainable technology development is a direct consequence of the normative implications of patent system proposals. The USPTO has been engaged in administrative patent levers to implement policy-oriented goals and to address technology-specific challenges, such as global climate concerns, which can impact research and development and innovation [49]. Regulation and legal instruments, including patent policy and administrative patent levers with the USPTO, can impose obligations or constraints on private sector behavior or can enhance the development, adaptation, and diffusion of clean and sustainable technologies [50].

Although environmental innovation has gained momentum, stakeholders should keep in mind various patent policy and administrative law considerations. As such, because of the broad variety of innovation mechanism where patents may have a role (such these technologies are patented, licensed, or shared in a pool), patent policy may be used to sensitize different environmental innovation considerations. For that purpose, a narrative review of various environmental innovation approaches involving patents in some form should be useful to innovators and policymakers for incentivizing clean and sustainable technological development and diffusion.

Conclusion

Climate change poses a major challenge to society. In order to deal with the rapidly changing environment, there is a need for clean and sustainable technology development that could assist in adapting to or mitigating climate change. The prospect of relying on patent incentives to adequately promote innovation in the environmental domain requires analysis of various approaches, mechanisms, and policy considerations.

Conflict of interest statement

Nothing declared.

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