
Promoting Environmental Innovation with Intellectual Property Innovation: A New Basis for Patent Rewards

Gregory N. Mandel*

Abstract: Despite numerous and diverse efforts, environmental law generally fails to promote technological innovation with environmental benefits. Such innovation could have myriad human health and environmental benefits, while simultaneously reducing the cost of environmental protection for industry and society. This Article explores whether intellectual property law can step in where environmental law has failed to efficiently provide greater incentives for environmental innovation. A patent rewards system for environmental innovation holds substantial promise. Because environmental innovation often produces significant positive externalities by reducing environmental harms for many individuals beyond the implementing firm, inventors do not face efficient incentives for environmental innovation—a market failure that patent rewards can ameliorate. Along these lines, the analysis reveals a previously unrecognized benefit of patent rewards in certain circumstances.

I. INTRODUCTION

Despite numerous and diverse efforts, one significant goal that environmental law generally fails to achieve is to promote technological innovation with environmental benefits. Technological advance in the environmental area could have myriad benefits—cutting pollution, reducing waste, improving conservation—and could provide these benefits while simultaneously reducing the cost of environmental

* © 2005 Gregory N. Mandel. Associate Professor of Law, Albany Law School. This Article is based on a presentation at the Temple University Journal of Science, Technology, and Environmental Law's Symposium: "Environmental Technology and Innovation: Partners for our Future." I am grateful to the Journal for inviting me to participate in their Symposium, to David Adelman for providing thoughtful comments on a draft of this Article, and to Kelly Marks for providing outstanding research assistance.

protection. Thus, the potential welfare gains are substantial, as both industry and the general public could be made significantly better off.

Recognizing the opportunity for environmentally beneficial technological innovation to improve social welfare, many environmental statutes include provisions intended to give private industry incentives or impose requirements to develop better environmental protection technology. Examples include the Clean Air Act,¹ Clean Water Act,² Resource Conservation and Recovery Act,³ and Safe Drinking Water Act.⁴ None of these laws, however, has been significantly successful in driving environmental innovation. Varied analyses, as well as a portion of this Symposium, have been devoted to examining these failures.⁵ Rather than further investigate these failures, this Article pursues a different purpose. Given that decades of environmental legislation and regulation have failed to provide adequate incentives to innovate for the benefit of the environment, this Article explores whether intellectual property law can step into environmental law's stead and efficiently provide greater incentives for environmental innovation.

United States intellectual property law offers certain, though perhaps limited, opportunities to promote technological innovation that has environmental benefits. Analysis reveals that most common proposals for patent law reform, such as compulsory licensing or streamlining patent acquisition, cannot reasonably be expected to significantly improve technological innovation with environmental benefit. One proposal, however—a shift to a patent rewards system—provides substantial promise for producing more efficient and greater incentives for environmental innovation. Because environmental innovation often produces substantial, positive externalities by reducing environmental harms for many individuals outside the implementing firm, inventors do not face efficient incentives for environmental innovation—a market failure that the patent rewards proposal stated here can ameliorate. Along these lines, the analysis reveals a previously unrecognized benefit of patent rewards systems in certain circumstances.

Understanding, and potentially advancing, opportunities for intellectual property reform to promote environmentally beneficial technological innovation requires an analysis of the incentives that inventors face under intellectual property law. The incentive analysis requires, in turn, a brief overview of United States intellectual property law in the context of technological innovation with potential environmental benefits. This type of technological innovation will be referred to as “environmental innovation” in this Article.

¹ 42 U.S.C. §§ 7401-7671q (2005).

² 33 U.S.C. §§ 1251-1387 (2005).

³ 42 U.S.C. §§ 6901-6992k (2005).

⁴ 42 U.S.C. §§ 300f-300j-26 (2005).

⁵ Margaret R. Taylor et al., *Regulation as the Mother of Innovation: The Case of SO₂ Control*, 27 LAW AND POLICY 348 (2005); David M. Driesen, Symposium, *The Economic Dynamics of Environmental Law: Cost-Benefit Analysis, Emissions Trading, and Priority-Setting*, 31 B.C. ENVTL. AFF. L. REV. 501 (2004); Envtl. Law Inst., *Barriers to Environmental Technology Innovation and Use* (1998) (criticizing technology-based emission limits (such as in the CAA and CWA) for discouraging innovation); Natalie M. Derzko, *Using Intellectual Property Law and Regulatory Processes to Foster Innovation and Diffusion of Environmental Technologies*, 20 HARV. ENVTL. L. REV. 3, 5 (1996).

II. INTELLECTUAL PROPERTY LAW FOR ENVIRONMENTAL INNOVATION

Two primary bodies of intellectual property law concern protection of technological invention—patent law and trade secret law.⁶ I discuss the opportunity for trade secret law to promote environmental innovation first, as its consideration will be brief.

A. Trade Secret Law

Trade secret law is state law, and as such varies from jurisdiction to jurisdiction.⁷ Trade secret law provides certain legal protection against misappropriation of business information that is not commonly known.⁸ The type of information protected by trade secret law is quite broad; it can include business processes or products, as well as confidential customer lists or business plans.⁹

A critical element of trade secret protection in every jurisdiction is that the trade secret information to be protected not be commonly or publicly known.¹⁰ Once information is publicly known, it is no longer a trade secret, and therefore no longer subject to trade secret protection.¹¹ This fundamental requirement renders trade secret law antithetical to driving significant industry-wide environmental innovation.

To clarify why trade secret law will not incentivize environmental innovation, it is useful to distinguish between the two main types of entities that are potential environmental innovators—firms that cause environmental degradation of some form as a byproduct of other, primary activity (for example, pollution from the generation of electricity), and firms whose primary business is developing products or processes to reduce environmental degradation (for example, new pollution scrubbers or conservation products). The latter, environmental innovation firms can only profit by disclosing their inventions. Environmental innovation firms' business is selling environmental innovation; they do not seek to keep environmental innovation a secret. Trade secret law will not improve innovation by environmental innovation firms.

The former type of potential environmental innovator is industry firms that cause environmental degradation. Advances in environmental protection made by such industry firms generally will increase operation costs. Even though such advances increase operation costs, firms may still implement them—for instance, for regulatory, public relations, or Good Samaritan purposes. Regardless of the reason, the implementing firm would prefer that competing firms implement the environmental

⁶ Other bodies of law provide protection for non-technological intellectual property. For instance, copyright law protects the rights of authors in fixed original artistic expression and trademark law protects ownership of distinctive marks.

⁷ MELVIN F. JAGER, 1 TRADE SECRETS LAW § 2.3 (2004); *Softel, Inc. v. Dragon Medical and Scientific Communications, Inc.*, 118 F.3d 955, 967-68 (2d Cir. 1997). The Economic Espionage Act, 18 U.S.C. §§ 1831-39, is one federal law that provides trade secret-like protection.

⁸ JAGER, *supra* note 7, at § 3.3; *Reeves v. Hanlon*, 33 Cal. 4th 1140, 1155 (Cal. 2004).

⁹ JAGER, *supra* note 7, § 3.3; *Reeves*, 33 Cal. 4th at 1155.

¹⁰ JAGER, *supra* note 7, § 3.2; *Ashland Management Inc. v. Janien*, 82 N.Y.2d 395, 407 (1993) (a “trade secret must first of all be secret”).

¹¹ JAGER, *supra* note 7, § 3.2; *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 476 (1974).

innovation as well, in order to level the operations-cost playing field. Environmental innovators in industry will not seek to keep their innovations secret; such secrecy would reduce their competitive standing. The bottom line is that trade secret law likely does not promote environmental innovation and cannot be used to further incentivize environmental innovation.

B. Patent Law

The essence of the patent system is a relatively simple bargain: an inventor discloses to the world what their new invention is and how it works in exchange for the right to exclude others from practicing the invention for a certain period of time. The authority for the federal government to enter this bargain is found in the United States Constitution: “The Congress shall have Power . . . [t]o promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.”¹² The purpose of patent law is thus to promote progress, a promising premise for the goal of incentivizing environmental innovation.

Patent law seeks to promote progress by enabling inventors to profit from their inventions through the award of a legal monopoly. A patent gives its owner the right to exclude anyone else from making, using, selling, offering for sale, or importing the patented subject matter during the patent’s term.¹³ The patent term is generally twenty years from the date the inventor applied for the patent; this patent term cannot be renewed.¹⁴ The potential grant of these exclusionary rights, and concomitant opportunity for monopoly pricing power, provides inventors with incentives to invest time, financial resources, and effort into research and development in order to innovate. In this manner, patent law promotes innovation.¹⁵

1. Patent Validity Requirements

To obtain a patent, an inventor must file a patent application with the United States Patent and Trademark Office (USPTO).¹⁶ To be granted a patent, the patent application must meet five validity requirements: subject matter, utility, novelty, non-obvious, and adequate disclosure.¹⁷ These five requirements are discussed briefly in the context of environmental innovation.

The subject matter validity requirement restricts the classes of inventions that are eligible for patenting. Pursuant to the Patent Act, processes, machines, articles of manufacture, and compositions of matter are patent-eligible.¹⁸ The Supreme Court

¹² U.S. CONST. art. I, § 8, cl. 8. Pursuant to the constitutional intellectual property clause, patent law is entirely federal law.

¹³ 35 U.S.C. § 271(a) (2005).

¹⁴ 35 U.S.C. § 154.

¹⁵ This discussion provides only a simplified explanation (sufficient for our purposes here) of the incentives offered by patent law. In practices, the incentives offered by patent law are quite complex and subject to considerable debate.

¹⁶ 35 U.S.C. § 111(a)(1).

¹⁷ 35 U.S.C. § 101-103, 112; *Bonito Boats, Inc. v. Thunder Craft Boats, Inc.*, 489 U.S. 141, 149-50 (1989).

¹⁸ 35 U.S.C. §101.

has interpreted this statutory language to cover “Anything under the sun made by man.”¹⁹ This interpretation renders the subject matter requirement, at most, a very minor hurdle to environmental innovation patenting. In particular, both processes and products are patent-eligible. A new manufacturing process that produces less pollution as well as a new remediation product both are patent-eligible.

Utility requires a demonstration that the invention will do what the inventor claims it does, and that what the invention does is useful.²⁰ Utility also presents a negligible hurdle for environmental innovation—inventions that have environmental benefits will be useful.

Novelty requires that the subject matter sought to be patented is new; in general, that it has not been previously patented, published, known or used by others.²¹ Though this requirement will bar patents on non-novel environmental innovations, such inventions, by definition, are already known or used in some manner. As a result, the novelty requirement for a valid patent will not prevent society from benefiting from environmental technology advances.

Perhaps the care patent validity requirement is the non-obvious requirement. An invention must be non-obvious in light of what is already known in order to receive a patent.²² Trivial advances over prior technology are not entitled to patent protection. The purpose of non-obvious requirement is two-fold: trivial advances do not benefit society sufficiently to deserve a patent monopoly, and society will acquire trivial advances anyway—such advances do not need to be incentivized. For our purposes, the non-obvious requirement is the most significant requirement—it will bar the patenting of novel environmental innovation, unless such innovation is non-obvious. Arguably this requirement could restrict certain environmental innovation as potential innovators calculate that their advance may be deemed obvious, precluding patent profits and reducing incentives to innovate. In general, however, the non-obvious standard is not applied very stringently; in fact, the standard is routinely criticized for being too easy to achieve.²³

Last, to receive a patent, the invention must be adequately disclosed, such that others would be able to make and practice the invention. This requirement forces the inventor to live up to their part of the patent bargain: disclosing the invention to the world. This requirement is not significant to the consideration of environmental innovation here—environmental innovation generally can be sufficiently disclosed in a patent application.

¹⁹ *Diamond v. Diehr*, 450 U.S. 175, 182 (1981). Laws of nature, physical phenomena, and abstract ideas are not patent-eligible. *Gottschalk v. Benson*, 409 U.S. 65, 67 (1972).

²⁰ DONALD S. CHISUM, 1 CHISUM ON PATENTS § 4.01 (2003); *In re Hartop*, 311 F.2d 249, 257 (C.C.P.A. 1962).

²¹ 35 U.S.C. §102.

²² “A patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains.” 35 U.S.C. §103(a) (2005).

²³ See, e.g., Mark A. Lemley et al., *Gold-Plated Patents*, LEGAL AFFAIRS (forthcoming 2005); John H. Barton, *Non-Obviousness*, 43 IDEA 475, 482-83 (2003); Sara Dastgheib-Vinarov, Comment, *A Higher Nonobviousness Standard for Gene Patents: Protecting Biomedical Research from the Big Chill*, MARQ. INTELL. PROP. L. REV. 143, 152-53 (2000); Michael J. Meurer, Symposium, *Business Method Patents and Patent Floods*, 8 WASH. U. J.L. & POL’Y 309, 337 (2002).

2. *Patenting Environmental Innovations*

As is evident from even this terse introduction, doctrinally patent law does not pose much of a barrier to patenting environmental innovations. An invention that lowers pollution production, improves remediation efficiency, or achieves better conservation in a new and non-obvious way can meet the patent validity requirements.

Despite this apparent fit, as noted in the introductory portion of this Article, there is considerable consensus that not enough environmental innovation takes place. Many commentators contend that there should be more environmental innovation—that there is potentially socially beneficial environmental innovation that should be, but is not, occurring.²⁴ Patent law, on the other hand, appears to offer significant incentives to anyone who can invent a new and non-obvious environmental technology—the inventor would acquire exclusionary rights in the invented subject matter and the potential to charge monopoly prices. Which view is correct, that environmental innovation is not sufficiently incentivized or that patent law offers substantial incentives? To answer this question, we must delve further into the nature of incentives that inventors, and particularly potential environmental inventors, face under patent law.

III. MARKET FAILURE IN ENVIRONMENTAL INNOVATION

The standard economic story for patent law (and for intellectual property law in general) is that absent patent protection, there would be a market failure in innovation—individuals and firms would invest less resources in inventive activities than is socially optimal, and therefore there would be less invention than is socially optimal.²⁵ This would occur because new inventions generally are non-excludable and non-rivalrous. Absent patent law, if I build a better mousetrap and commercialize it or make it publicly known (usually a necessary antecedent to profiting from my invention), I cannot prevent you from copying my invention many times over without paying me any royalties. Invention thus has a public good aspect—one individual's use does not reduce another's.²⁶ It is very easy for others to appropriate my mousetrap and not have to share in the cost of invention. As a result, I cannot profit very much from my invention, or cannot profit from it to the full extent of its social value.²⁷ Being a rational person, I will recognize the limited available profits *ex ante*, and will decide not to put a lot of effort into invention. I will not invest as much time, effort, dollars, research and development, or

²⁴ See *supra*, note 5.

²⁵ See, e.g., *Kewanee Oil Co. v. Bicron*, 416 U.S. 470, 480-81 (1974) (discussing how the prospect of obtaining a patent monopoly provides an incentive to invest in efforts to create new inventions); Brett Fischmann, *Innovation and Institutions: Rethinking the Economics of U.S. Science and Technology Policy*, 24 VT. L. REV. 347, 373-74 (2000) (explaining the market failure in innovation).

²⁶ See RICHARD A. POSNER, *ECONOMIC ANALYSIS AND THE LAW* 41 (2003) (defining public good).

²⁷ Because anyone can free ride on an invention in the absence of patent law, free competition will reduce the market price of the invention to the cost of production, eliminating any return on investment in inventive activities, such as research and development costs.

commercialization effort as is optimal based on the potential social value of the invention. Too little invention occurs.

Patent law solves this market failure by bringing the private benefits of invention more in line with their social value. Once I have a patent on my mousetrap, the world has to beat a path to my door. Consequently, I can reap appropriate rewards (or more appropriate rewards), primarily through monopoly pricing. Monopoly pricing allows me to charge a price for my mousetrap that more closely approaches the value that consumers place on the mousetrap compared to the value placed by a competitive price.²⁸ Allowing the inventor to charge prices that approach the social value of an invention creates incentives for inventors that more accurately reflect the social welfare produced by the invention. Patent law thus provides private incentives to invent, disclose, and commercialize inventions.²⁹

The foregoing analysis applies reasonably well to most technology.³⁰ Environmental innovation, however, adds another twist. Environmental innovation, absent patent law, would face the same market failure as other subject matter—individuals and firms would not engage in enough environmental innovation absent patent law because competitors could free ride on others' inventive efforts and expenses, reducing the incentive to invent below its socially optimal level. But, environmental innovation faces a second market failure as well, a market failure that results from the positive environmental externalities provided by environmental innovation. It is this latter market failure that reveals why existing patent law, though providing appropriate incentives for most innovation, is not sufficient to drive environmental innovation to socially optimal levels.

Positive environmental externalities exist for environmental innovation because firms implementing environmental innovations do not reap all the social, health, or environmental benefits produced by the environmental innovations.³¹ Implementation of environmental innovation that reduces pollution, improves remediation, enhances conservation, or otherwise provides environmental benefit has substantial salutary effects for many members of society, far beyond the firm that implements the innovation. Framed another way, environmental invention has significant benefits beyond those received by the consumer of the invention. Environmental innovation thus suffers two public good problems—the invention

²⁸ A competitive price would be based on the cost of production of the mousetrap, without any supplement for the cost of inventive activities, such as research and development *See id.*

²⁹ *See generally* Rebecca Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 U. CHI. L. REV. 1017 (1989) (discussing how patent law provides these incentives).

³⁰ The incentive to invent theory, which is what is roughly described here, certainly does not provide a full picture of the economic basis for patent law. It has been criticized in numerous regards, including: for failing to adequately consider that patent monopolies restrict the use of inventions, thereby reducing the social benefits of inventions; that patent incentives may distort economic activity in ways that retard efficiency; and that patent rights may hinder the ability of other inventors to make improvements upon pioneer inventions. *See id.* (surveying and critiquing a variety of economic theories of patent law). For the purposes of evaluating incentives for environmental innovation, however, the incentive to invent theory provides an adequate basis for analysis.

³¹ *See* FRED BOSSELMAN ET AL., *ENERGY, ECONOMICS AND THE ENVIRONMENT* 41-44 (2000) (describing the role of externalities in environmental protection); Taylor, *supra* note 5, at 348 (noting that industry tends to under-invest in “environmental technologies because of their public good characteristic”).

public good problem and the environmental public good problem.³²

A rational profit-maximizing firm will not implement an environmental innovation unless the firm expects to benefit from it in some manner, and to benefit from it in a greater amount than the cost of implementation. As discussed above, that benefit may come from regulatory requirements, public or worker relations, Good Samaritans, or other goals. In general, however, a firm considering whether to implement additional environmental innovation will not take into account the benefit society reaps from the innovation in the form of improved environmental conditions, but only accounts for the benefit that the firm itself receives. Because firms are not rewarded for the full social benefits of implementing environmental innovation, they do not face the socially optimal incentives to implement. Firms are incentivized by potential savings in operations, but not by potential environmental enhancement. Firms, therefore, will not pay full social value for environmental innovation.³³ Consequentially, environmental innovators, whether in industry or the environmental innovation business, do not receive the socially optimal level of incentive to produce environmental innovation. Too little environmental innovation occurs.

Understanding the market failures that lead to an inefficient level of technological innovation with environmental benefits provides guidance in how to modify intellectual property law in order to provide socially optimal incentives for environmental innovation.

IV. CURING THE ENVIRONMENTAL INNOVATION MARKET FAILURE

For an intellectual property regime to provide optimal incentives to inventors for environmental innovation, the regime will have to solve both market failures—the invention market failure and the positive environmental externality market failure. Solving the invention market failure is the less daunting problem—existing intellectual property regimes, such as patent law, already do this to a significant degree.³⁴ The positive environmental externality market failure, however, presents new difficulties for intellectual property law.

Solving externality problems require internalizing the externalities.³⁵ Law must bring private environmental innovators' incentives to innovate in line with the actual societal value of their potential inventions. Placing private innovators' incentives in accord with the social value of innovation will lead private innovators to engage in the socially optimal level of innovation.

The following sections analyze the potential for a wide variety of patent law reforms to achieve the goal of internalizing the positive externalities of environmental benefit, and thus their potential for solving the environmental innovation market failure. The patent reforms considered include compulsory licensing, modifying the patent term, streamlining the patent process, lowering

³² See BOSSELMAN, *supra* note 31 (discussing the public good aspect of environmental protection).

³³ See *supra* notes 27-32 and accompanying text.

³⁴ But see Eisenberg, *supra* note 29 (discussing various economic theories of patent that contend patent law does not efficiently incentivize invention).

³⁵ Hanoch Degan & Michael Heller, *Conflicts in Property*, 6 THEORETICAL INQUIRES IN LAW 37, 43 (2005).

patent standards, and introducing a patent rewards system. The analysis reveals that only the last reform, patent rewards, offers significant potential for curing the market failure in environmental innovation.

A. Compulsory Licensing

Under the current patent system, each patent owner has exclusive authority to decide whether to license his or her patent rights at all, and if so, then who to license them to and under what conditions to license them. Compulsory licensing would introduce a mandatory requirement that a patent owner license his or her patent rights to licensees for a fee so that licensees may make and sell the patented subject matter. Compulsory licensing is very uncommon in United States patent law, and generally is frowned upon as an invasion of private property rights.³⁶

Compulsory licensing has been promoted by some as an advantageous patent law reform, particularly in the area of pharmaceuticals. Many commentators have argued that instituting compulsory licensing for pharmaceuticals will reduce the high cost of medicine and increase patient access to life-critical medication, with concomitant social welfare benefits.³⁷

Regardless of whether compulsory licensing would be a beneficial reform for the pharmaceutical or other industry, it will not provide greater incentives for environmental innovation. Compulsory licensing is only a useful reform in industries or situations where a patent owner is licensing their invention not at all or only limitedly. Environmental innovation does not fall within this category. For the same reason that trade secret law cannot promote environmental innovation purposes, compulsory licensing cannot help either. Firms rarely, if ever, have incentives to secret or not license environmental innovation. Consider again the two types of firms that produce environmental innovation. Environmental innovation firms will only profit by licensing their inventions. Similarly, industry generally faces increased operational costs from environmental innovation, so industry firms will want competing firms to adopt any environmental innovations as well to level the operations cost playing field. It would be extremely rare for a firm to achieve an environmental innovation that provided such an operational advantage that the competitive benefits of keeping the invention to the firm (not licensing it) would outweigh the profits of commercialization.³⁸

³⁶ *Hartford-Empire Co. v. United States*, 323 U.S. 386, 415 (1945) (“[t]hat a patent is property, protected against appropriation both by individuals and by government, has long been settled.”). The primary situation in which compulsory licensing exists in United States patent law is that owners whose patents have been infringed by the United States government have a cause of action in the Court of Federal Claims to receive compensation for the infringement. 28 U.S.C. § 1498(a) (2005). Because private plaintiffs are not entitled to injunctions against infringement by the United States, this effectively creates a compulsory licensing scheme whereby the United States may force the licensing of any patent. *See Pitcairn v. United States*, 547 F.2d 1106, 1118 (Ct. Cl. 1976) (holding that owner of patent infringed by the United States is only entitled to damages, not an injunction).

³⁷ *See, e.g.*, Grace K. Avedissian, Comment, *Global Implications of a Potential U.S. Policy Shift Toward Compulsory Licensing of Medical Inventions in a New Era of “Super-Terrorism,”* 18 AM. U. INT’L L. REV. 237, 248 (2003); Gianna Julian-Arnold, *International Compulsory Licensing: The Rationales and the Reality*, 33 IDEA 349, 353-54 (1993).

³⁸ If such a rare circumstance were to occur, the government likely could still acquire the patent under its eminent domain power. *See supra* note 36; Donald G. McNeil, *A Rush for Cipro, and the Global*

Furthermore, solving the positive environmental externality market failure requires increasing environmental innovators' incentives to invent. Compulsory licensing, however, reduces the value of an invention, by limiting the patent owner's opportunity to engage in monopoly pricing or to control the market for the invention, and therefore reduces potential inventors' incentives to invent.³⁹ Compulsory licensing would be expected to actually deter environmental innovation.

Though United States patent law generally frowns upon compulsory licensing, a few limited exceptions exist that allow compulsory licensing in particular circumstances. The most pertinent example of compulsory licensing, with respect to environmental innovation, lies in the Clean Air Act. The Clean Air Act permits a private party to apply to the Environmental Protection Agency and the United States Attorney General to require a patent owner to license a patent for an invention that is necessary to comply with certain air emission standards.⁴⁰ To receive a compulsory license, an applicant must satisfy three elements: (1) the patented device must be "used or intended for public or commercial use" and not "reasonably available;" (2) no other reasonable method for complying with the emissions standards may exist; and (3) failure to obtain the license would result in a "substantial lessening of competition or a tendency to create a monopoly in any line of commerce."⁴¹ Despite the existence of these compulsory licensing provisions since the Clean Air Act was enacted thirty-five years ago,⁴² they apparently have never been used. This supports the conclusion that environmental innovation will be licensed relatively efficiently without the necessity of compulsory licensing.⁴³

B. Modifying the Patent Term

A second potential patent reform would be to modify the patent term for patents on environmental inventions. Lengthening the patent term beyond twenty years would theoretically increase the potential profits from the patent, and therefore create

Ripples, N.Y. Times, Oct. 17, 2001, at A1 (discussing the proposal that the government exercise its eminent domain power to acquire the Cipro patent).

³⁹ See F. Scott Kieff, *Patents for Environmentalists*, 9 WASH. U. J.L. & POL'Y 307, 314 (2002) (arguing that a liability rule—*e.g.*, compulsory licensing—for patent law would frustrate the goals of incentivizing and distributing invention).

⁴⁰ 42 U.S.C. § 7608. The air emission standards pursuant to which a compulsory license may be sought are those established in 42 U.S.C. §§ 7411, 7412, and 7521.

⁴¹ 42 U.S.C. § 7608(1)-(2) (2005). If a compulsory license were granted, the patent owner is entitled to "adequate" compensation based on the economic value of the license. 40 C.F.R. § 95.4(a)(7). The license is nonexclusive, non-assignable, and restricted in scope and duration as necessary to fulfill the Clean Air Act's emission requirements. *Id.* § 954.4(a)(1)-(3).

⁴² See Clean Air Act of 1970, Pub.L. No. 91- 604, § 12(a), 84 Stat. 1676, 1708 (1970) (mandatory license provision in the Clean Air Act of 1970).

⁴³ The Clean Air Act appears to be the only example of a private party being able to initiate a compulsory license. In addition to the United States' general authority to force the compulsory license of a patent for government use, *see* note 36, several other statutes provide specific authority for the United States to require the licensing of patented subject matter in certain circumstances. *See, e.g.*, The Plant Variety Protection Act, 7 U.S.C. § 2404 (2005) (allowing the Secretary of the Department of Agriculture to make available a patented variety to assure "adequate suppl[ies] of fiber, food, or feed" where the owner will not or cannot provide for the public needs at a reasonably fair price); The Atomic Energy, 42 U.S.C. § 2138 (2005) (providing for a mandatory license of a patent that claims an invention or discovery that primarily uses or produces nuclear material or atomic energy in certain circumstances).

a greater incentive to innovate in the first instance.⁴⁴ Adjusting patent terms for different industries to provide socially optimal incentives to invent in each industry has been suggested as an appropriate reform by several commentators.⁴⁵

Lengthening the patent term for environmentally beneficial patents likely would not significantly increase incentives for environmental innovation. Most environmental innovations have useful lives of less than twenty years. Usually within this period of time, operations have changed substantially enough that a twenty year-old invention is no longer operationally useful. As a result, this reform would not significantly increase incentives to invent.⁴⁶ In addition, this reform would not assist in internalizing the positive environmental externalities of environmental innovation; thus, to the extent it might increase incentives to invent, it would not do so efficiently in relation to the market failure in environmental innovation.

C. Streamlining Patent Prosecution

Streamlining the process for obtaining patents on environmental innovations could increase incentives to innovate in this area. Patents are obtained through a process called patent prosecution. This process begins with submitting an application to the USPTO.⁴⁷ The USPTO reviews the application and may go through several rounds of internal evaluation, deliberation with the applicant, and appeals before a final decision to grant or deny the patent is reached.⁴⁸

Patent prosecution is neither a cheap nor rapid endeavor. The average prosecution takes close to three years and costs several tens of thousands of dollars in attorneys' fees and other expenses.⁴⁹ More complicated patent applications, a category that many environmental innovations may fall into,⁵⁰ take longer and cost more. In addition to being more costly, longer prosecution periods further decrease

⁴⁴ See Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813, 1823 (1984) (arguing that lengthening the patent term will increase research and invention).

⁴⁵ See, e.g., Robert A. Boher & John T. Price, *A Tale of Two Proteins: The FDA's Uncertain Interpretation of the Orphan Drug Act*, 12 HARV. J.L. & TECH. 365, 379 (1999) (suggesting extending patent terms for biotechnology inventions); Doris Chen, Tim Huang, & Dennis Fernandez, *Strategic Balancing of Patents and The Wireless Revolution to Maximize Market Exclusivity*, 87 J. PAT. & TRADEMARK OFF. SOC'Y 5 (2005) (proposing longer patent terms for wireless communication innovations); Richard Gilbert & Carl Shapiro, *Optimal Patent Length and Breadth*, 21:1 RAND J. ECON. 106, 110-11 (1990) (suggesting infinite patent terms for patents where the price of the patented product is close to its marginal cost and the patent is narrow in scope).

⁴⁶ See SUBCOMMITTEE ON PATENTS, TRADEMARKS, AND COPYRIGHTS, 85TH CONG., AN ECONOMIC REVIEW OF THE PATENT SYSTEM 72 (Comm. Print 1958) (noting that many patented inventions are not useful for the entire life of their patent).

⁴⁷ 35 U.S.C. § 111.

⁴⁸ 35 U.S.C. §§ 131-134.

⁴⁹ John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 VAND. L. REV. 2099, 2118 (2000) (surveying patent prosecution time periods); Corey B. Blake, *Ghosts of the Past: Does the USPTO's Scientific and Technical Background Requirement Still Make Sense?*, 82 TEX. L. REV. 735, 746 (2004) (noting that prosecution costs for original patent applications average \$20,000).

⁵⁰ On the other hand, mechanical and electronic inventions, (which many environmental innovations will be), generally spend a shorter time in prosecution than average. Allison & Lemley, *supra* note 49, at 2126.

the value of a patent because the patent term runs from the date of application—time spent in prosecution is time lost from the patent term.⁵¹ Streamlining the process so that it is quicker and cheaper to prosecute environmental patents would make such patents more attractive to potential innovators, and therefore should increase incentives to invent.⁵²

In fact, regulations already prioritize environmental patents.⁵³ These regulations, however, are rarely utilized, which indicates that speeding up the prosecution process is of little use to environmental innovators.⁵⁴ More critically, reducing the time spent in patent prosecution will not offer significant incentives for environmental innovation. As faster prosecution saves the applicant money in addition to time, the failure to use this provision also indicates that reducing the expense of environmental patent prosecution will not significantly increase incentives for environmental innovation.

These conclusions are supported by the reality of most environmental innovation. The research and development costs, and time devoted to most environmental innovation, likely substantially exceed the delays and expense of patent prosecution. Consequently, improvements through streamlining patent prosecution would not significantly increase incentives for environmental innovation. Nor would they internalize the positive externalities of environmental benefit.

D. Lowering Patent Standards

Some commentators have recommended lowering patent standards as a means to increase incentives to invent.⁵⁵ For inventions with environmental benefit (as with many other industries), this effectively requires lowering the non-obvious standard, as this is the primary hurdle to patenting environmental innovation.⁵⁶ At least one commentator has recommended such a change for environmental innovation in particular, reasoning that making it easier to obtain an environmental patent will increase the incentives to invest research and development resources into environmental innovation.⁵⁷

The argument that lowering patent standards will increase innovation is based in part on a “prospect theory” of patent law. Under prospect theory, developed by Edmund Kitch, the patent system can optimize social benefit by awarding broad,

⁵¹ 35 U.S.C. § 154.

⁵² See W. Less & Travis Lybbert, *Do Patents Come Too Easy?* 44 IDEA 381, 387 (2004) (noting that increases in patent prosecution time generally result in fewer applications being filed).

⁵³ 37 C.F.R. § 1.102(C) (2005) (“A petition to make an application special may be filed [on the basis] that the invention will materially enhance the quality of the environment or materially contribute to the development or conservation of energy resources”).

⁵⁴ Theoretically, this limited use alternatively could indicate that there are few environmental patents or that environmental applicants simply do not know about this provision. There is little evidence for either of these propositions.

⁵⁵ Derzko, *supra* note 5, at 14; Kevin Rhodes, Comment, *The Federal Circuit’s Patent Nonobviousness Standards: Theoretical Perspectives on Recent Doctrinal Changes*, 85 NW. U. L. REV. 1051, 1090 (1991).

⁵⁶ See *supra* Part I.B.1.

⁵⁷ Derzko, *supra* note 5, at 14-15.

exclusive rights in technological prospects shortly after their discovery.⁵⁸ By awarding early, broad patent rights, inventors will have very high incentives to innovate, and the owner who obtains the patent can then efficiently direct and coordinate further research in the technological area, reducing the inefficiency of free-for-all redundant research efforts by multiple firms.⁵⁹

Prospect theory, however, has several fundamental problems. Salient criticisms of prospect theory include that it assumes that patent rights will be granted early in the development process, which usually is not the case,⁶⁰ it assumes that the pioneer patentee will also have rights to subsequent refinements, which is not always the case,⁶¹ it fails to account for the inefficiency of competitors inventing around patents,⁶² and, perhaps most significantly, it fails to account for the inefficiency created by exacerbating a race to patent pioneer inventions in attempts claim whole technological areas.⁶³ Prospect theory only considers efficiency at the improvement stage, arguing that coordinated improvement will be more efficient than a competitive, redundant market for improvement.⁶⁴ It is unclear why a competitive market for improvement would free market competition and is commonly thought to produce invention relatively efficiently.⁶⁵ But, even assuming competition for improvement would be inefficient, prospect theory fails to recognize that the prospect proposal would simply shift inefficiencies in races-to-develop from the improvement stage to the pioneer stage.⁶⁶ Under a prospect approach there would be even more inefficient redundant innovation activity at early invention stages.

In addition to the general deficiencies in prospect theory noted above, lowering the non-obvious (or any other) patent validity requirement for environmentally beneficial technology in particular will not result in greater innovation. First, as discussed, the non-obvious standard as it stands now does not present much of practical hurdle to environmental innovation.⁶⁷ Second, obvious advances will be achieved anyway (without lowering standards), because they will be evident. Holding out the carrot of a patent is unnecessary to incentivize trivial advances. Lowering the obvious standard would simply reward a (relatively random) person with monopoly profits, where such reward was unnecessary for acquisition of the invention by society. Third, lowering patenting standards would likely result in a rush to the patent office to patent obvious advances. Such a scenario would create a patent thicket or anti-commons, wherein it would become extremely difficult and expensive to patent improvement advances because potential inventors would have a

⁵⁸ Eisenberg, *supra* note 29, at 1040-41.

⁵⁹ *Id.* at 1041-42.

⁶⁰ *Id.* at 1042 n.48.

⁶¹ John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439, 442-43 (2004).

⁶² Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 183 (2003)

⁶³ Duffy, *supra* note 61, at 492.

⁶⁴ See Eisenberg, *supra* note 29, at 1040-42 (explaining prospect theory).

⁶⁵ See Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 908 (1990) (contending that free market competition is general preferable for cumulative inventions).

⁶⁶ *Id.* at 871.

⁶⁷ See *supra* Part I.B.1.

hard time obtaining all the license rights necessary to conduct research, development, or commercialization.⁶⁸ The rush to obtain obvious pioneer patents would block anyone from improving upon those patents with greater environmental innovation.

In short, lowering the non-obvious standard would result in substantial inefficiencies due to the grant of unnecessary monopolies and causation of patent thickets. In addition to creating these new inefficiencies, lowering patent standards would not ameliorate the primary inefficiency we are concerned with here—the failure of private entities to internalize the positive externalities of environmental benefit.

E. Patent Rewards System

A patent rewards system would represent a significant shift from the current patent regime. Under a rewards system, the government acquires rights to patentable subject matter that meets the five validity requirements, and in exchange, financially compensates the inventor directly instead of granting them a patent.⁶⁹ The invention is then made available for use to the general public, either freely or for a fee. Under most patent rewards proposals, compensation is based on the inventor's expected profit,⁷⁰ but for the purposes of environmental innovation, compensation could be based on the expected environmental benefit provided to society by the invention.⁷¹

The proposed patent rewards system would shift an inventor's expected invention profits from compensation based on market profits to compensation based on the social benefit provided by the invention. This shift would accomplish the desired goal of internalizing the positive externalities of environmental innovation. The patent rewards system would bring private incentives in line with the social value of an invention, optimizing the incentive for inventors to innovate.

Patent rewards systems have been the subject of a considerable number of scholarly proposals recently.⁷² These proposals, however, have not identified the

⁶⁸ See Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1681 (2003) (discussing the problem of a patent thicket resulting from a lowered non-obvious standard); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698 (1998) (discussing the problem of patent anti-commons); John H. Barton, *Reforming the Patent System*, 287 SCI. 1933 (2000) (arguing that the non-obvious standard is too low and too many minor patents are issued).

⁶⁹ See Steve P. Calandrillo, *An Economic Analysis of Intellectual Property Rights: Justifications and Problems of Exclusive Rights, Incentives to Generate Information, and the Alternative of a Government-Run Reward System*, 9 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 301, 306-07 (1998) (discussing the elements of a patent rewards system). A rewards system was favored by George Washington and Alexander Hamilton at the time the Constitution was being drafted, views that did not prevail.

⁷⁰ See, e.g., Robert C. Guell & Marvin Fischbaum, *Toward an Allocative Efficiency Prescription Drug Industry*, 73 MILBANK Q. 213, 221 (1995) (discussing a patent rewards system for prescription drugs with the reward to the inventor based on the net present value of what the patent would have generated on the market).

⁷¹ See, e.g., Steven Shavell & Tanguy Van Ypersele, *Rewards Versus Intellectual Property Rights*, 44 J.L. & ECON. 525, 534-35 (2001) (proposing a patent rewards system with the reward based on the "lowest possible social surplus" provided by the invention, although still based on the quantity of invented product demanded).

⁷² See Abramowicz, *supra* note 62; Guell & Fischbaum, *supra* note 70; Shavell & Ypersele, *supra* note 71; Michael Kremer, *Patent Buyouts: A Mechanism for Encouraging Innovation*, 113 Q.J. ECON. 1137

potential benefit a rewards system provides for inventions whose use produces significant positive externalities.⁷³ Rather, these proposals have focused on an additional benefit provided by patent rewards systems—they reduce the deadweight loss created by grants of traditional patent monopoly rights.⁷⁴ Under a traditional, exclusionary patent grant, the owner obtains a monopoly. The patent owner can then raise the commercial price of their invention above the competitive price in order to garner greater (“monopoly”) profits.⁷⁵ Such pricing, however, means that certain firms or consumers who value the invention above its cost of production nevertheless will not purchase the invention because of its higher monopoly price.⁷⁶ This creates a deadweight loss.⁷⁷ A rewards system reduces or eliminates the deadweight loss because it eliminates monopoly pricing power.⁷⁸

Patent rewards systems, in general, produce other benefits beyond reducing deadweight loss. Rewards systems, for instance, reduce the inefficiency of firms expending resources to invent around competitors’ patents.⁷⁹ Because the invention is available to all, there is no need to avoid competitors’ patents in research or commercialization. Rewards systems also reduce the transactions costs of licensing patents, and concomitantly, reduce the risk and cost of inefficient patent thickets.

A patent rewards system for environmental innovation (or for other innovation whose implementation produces significant positive externalities beyond the implementing firm or consumer) will provide both the general rewards system benefits and the benefit of internalizing the positive externalities of environmental innovation. It will thus solve both the invention market failure and the positive environmental externality market failure, resulting in substantially greater and more efficient incentives for environmental innovation.

A patent rewards system for environmental innovation does not require an overhaul of the current patent system. Rather, such a system could efficiently be implemented in parallel to existing patent law and procedure. Most inventors would still use the extant patent system to acquire exclusionary patent rights, and reap market monopoly profits. But, where an inventor of an environmental innovation believes that their invention has significant social value in excess of expected market profits, he or she may opt into the patent rewards system.⁸⁰ The patent rewards system thus could be woven into the existing patent system, without requiring major

(1998); Douglas Gary Lichtman, *Pricing Prozac: Why the Government Should Subsidize the Purchase of Patented Pharmaceuticals*, 11 HARV. J.L. & TECH. 123 (1997).

⁷³ For a discussion of using a patent rewards system to capture the social returns of invention generally that are not reflected in the market, see Kremer, *supra* note 72.

⁷⁴ See, e.g., Abramowicz, *supra* note 62, at 132-33 (“the patent buyout benefits society as a whole by eliminating deadweight loss”).

⁷⁵ Guell & Fischbaum, *supra* note 70, at 216-17.

⁷⁶ Abramowicz, *supra* note 62, at 128-29.

⁷⁷ *Id.*

⁷⁸ *Id.*, at 131-33.

⁷⁹ *Id.*, at 192-93. Abramowicz points out that whether a rewards system is more efficient in this regard is debatable, as placing the invention in the public domain may also lead to inefficient excessive research on improvement inventions. *Id.*

⁸⁰ See Shavell & Ypersele, *supra* note 71, at 537-39 (proposing an optional patent rewards system); Kremer, *supra* note 72 (suggesting an opt-in patent reward system).

changes. It also would preserve the autonomy of private inventors, who would maintain the right to choose how to handle their inventions.

The risks of the proposed rewards system are low. If the numerous criticisms of environmental law's failure to drive environmental innovation turn out to be unsound (that is, if environmental law does drive environmental innovation relatively efficiently), implementation of this proposal will have little negative impact or cost. If environmental innovation is already incentivized, little additional innovation will occur as a result of this proposal, and few rewards will have to be paid. In this regard, the incentives provided by environmental law and by patent rewards complement each other.

The primary, potential, new difficulty that a patent rewards system introduces is that an administrative body will have to determine the value of inventions whose owners chose patent rewards. Identifying the social value produced by an invention is not an easy task. This hurdle should not be understated, but it may not be as substantial as it may first appear. First, there already is one example of a patent rewards system in the United States patent system. For national security reasons, individuals may not receive patents on atomic energy inventions.⁸¹ Individuals who achieve atomic energy inventions, however, may receive a patent reward.⁸² The reward is set by a Patent Compensation Board, based in part upon the actual use and importance of the invention.⁸³ Relatedly, the government can effectively force the compulsory licensing of patented inventions for its own use.⁸⁴ Where negotiations over the value of the license fail, the government may still use a patented invention; this government use results in a takings claim by the patent owner, and a court must fix the value of the patent.⁸⁵

Second, valuing environmental benefit is a practice that multiple administrative agencies already engage in, both explicitly and implicitly. Setting almost any regulatory standard requires balancing, in some manner, the benefit to be obtained from environmental improvement against the cost of implementing that regulation. Most environmental statutes and regulations already require this, either in the form of cost-benefit balancing or in the form of determining the feasibility of certain environmental protection.⁸⁶ Regulatory agencies already routinely value environmental benefit. Valuing the social benefit of environmental innovation is a difficult, but achievable, task.

⁸¹ 42 U.S.C. § 2181.

⁸² 42 U.S.C. § 2187.

⁸³ 42 U.S.C. § 2187(c).

⁸⁴ *See supra* note 36.

⁸⁵ *See, e.g.,* *Zoltek Corp. v. United States*, 58 Fed. Cl. 688 (2003); *Motorola, Inc. v. United States*, 729 F.2d 765 (Fed. Cir. 1984).

⁸⁶ *See, e.g.,* The Toxic Substances Control Act, 15 U.S.C. § 2605 (requiring the Environmental Protection Agency to engage in risk-benefit balancing to protect against "unreasonable risk" from toxic substances); The Clean Air Act, 42 U.S.C. § 7612 (requiring a feasibility-based approach to environmental protection standards); The Safe Drinking Water Act, 42 U.S.C. § 300g-1 (requiring a feasibility-based approach to national primary drinking water standards). Statutes that regulate based on any health effect, i.e. regulate to zero risk levels (such as the Delaney Clauses, 21 U.S.C. § 376(b)(5)(B)), or statutes that simply provide for the provision or dissemination of information (such as the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. §§ 11001-11050) do not require valuation of the environmental benefit received in this regard.

There are four main criticisms leveled against patent rewards systems in general: (1) they fail to incentivize commercialization of inventions (as opposed to simply incentivizing invention), (2) rewards based on marginal costs do not adequately reward (or, therefore, adequately incentivize) inventors for fixed costs, (3) opt-in rewards systems do not weed out invalid patents, and (4) administering rewards systems are costly.⁸⁷ With the exception of the last criticism, these critiques are not significant for the patent rewards system proposed here.

First, for environmental innovation, there will not be a failure in commercialization. As discussed, implementation of most environmental innovation increases operational expense. Such innovation will only be adopted as the result of government regulation (whether feasibility-based, command-and-control, or other regulatory mechanism) or market/consumer pressure. Government regulation or market/consumer forces will thus force (or not force) ‘commercialization’ of environmental innovation independent of the intellectual property regime in place.⁸⁸ Environmental innovations that reduce operational expenses, on the other hand, will be adopted by industry for competitive purposes; the market will provide adequate incentives for adoption of these innovations.⁸⁹

As to the second critique, under the patent rewards system proposed here, rewards are not based on pricing the invention at its marginal cost, but at its social value. Proper incentives are thus provided. Because this proposal anticipates that reward patents will still have to pass the patent validity requirements, and because inventors will only be rewarded based on the social value provided by their invention, rewards will not be provided for unworthy or invalid patents.

The final critique of a patent rewards system concerns the cost of administering the system. Though these costs cannot be ignored, they do not council against such a system here. A rewards system creates two types of costs: the costs of administering the system and the cost of the rewards themselves. The most significant administrative cost of the rewards system proposed likely is calculating the social value provided by environmental innovations. As discussed, substantial resources already are devoted to accomplishing this task pursuant to the United States’ existing

⁸⁷ Abramowicz, *supra* note 62, at 172-211; *see also* F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697 (2001) (critiquing patent rewards systems for their failure to efficiently incentivize commercialization of inventions).

⁸⁸ To the extent environmental innovations will not be implemented, they would not be implemented outside of a patent rewards system either. The patent rewards system will only increase, not reduce, industry penetration of environmental innovation. Further, patent rewards for environmental innovation that will not be implemented should be low or zero, as rewards are based of the social benefit produced by the invention.

These understandings also highlight that patent incentives alone will not lead to widespread adoption of environmental innovations that significantly increase operations costs. Regulatory requirements or market/consumer influences will also be necessary. *See* Taylor, *supra* note 5, at 371-72 (“Without the market stimulated by government regulation, patenting activity levels are extremely low”). Where increases in operations costs are low or negative (i.e., the innovation reduces costs through conservation or because it is a cheaper technology), patent incentives alone may be enough to generate industry adoption.

⁸⁹ *But see* Linda Green & Christopher Van Löben Sels, *When Pollution Prevention Meets the Bottom Line* (Sept. 1977), <http://pubs.acs.org/hotartcl/est/97/sept/when.html> (case study revealing that firms may not implement pollution and waste reducing operations even where such implementation may be cost efficient).

environmental laws and regulations. In addition, the added cost of expanding the existing Patent Compensation Board to handle environmental innovation, though not *de minimis*, pales in comparison to the potential benefit of offering substantially more efficient incentives for technological innovation with environmental benefits.⁹⁰ Finally, the financial patent rewards provided under the proposed system should be offset by the cost of administering the rewards system. This is an unfortunate but necessary transaction cost. The offset is efficient—the social benefit provided by an invention is reduced by the cost of administering rights in the invention, whether through traditional patent rights or rewards—and to a certain extent will allow the rewards system to pay for itself in terms of net social welfare. This is an accomplishment that the current patent system does not achieve.

Determining the exact social value of an invention is, admittedly, an impossible task. Not only would it require calculating how much society benefits from particular environmental innovation, but it would also require analysis of numerous second-order effects. These would include (but are not limited to): economic and incentive distortions caused by the potential grant of a reward, rent-dissipation from multiple inventive efforts at various stages of invention, and determination of the value of the invention for its impact and contribution to future inventive activity. These spillover difficulties do not indicate, however, that approximate valuation will not provide accurate enough incentive signals to produce greater social welfare. First, so long as rewards are not systematically skewed to be either too high or too low—as long as rewards average the appropriate valuation, and inventors have no *ex ante* knowledge of how their invention will be treated—patent rewards will provide the proper incentive. More importantly, there is no reason to expect that the market values inventions more accurately than a rewards system would generally, and in the case (as here) where there are significant externalities that result from the use of an invention, the market is expected to value the invention much less accurately than a patent rewards system. In order to be beneficial, valuation under a rewards system does not have to be perfect, only accurate enough to make up for any increased administrative cost of the system. Considering the substantial positive externalities, this appears to be an easily attainable requirement, rendering the proposed rewards system a desirable “second-best” reform.

The cost of paying inventors their rewards likely will be significant. The rewards will be based on the social benefit provided by the environmental innovation, and inventions with significant environmental benefit may be worth a substantial social amount. Importantly, however, so long as the system is administered properly, the grant of rewards by definition will be social welfare efficient. The government will not pay more for a reward than it is worth socially. To the extent taxes are increased, for example, to pay for the rewards, such taxation will result in improved social welfare across society.

⁹⁰ The cost of administering rewards would include the reality that such administration could not be expected to occur in a fully efficient manner. In reality, administrative agency operation often contains multiple flaws. See, e.g., Gregory N. Mandel, *Gaps, Inexperience, Inconsistencies, and Overlaps: Crisis in the Regulation of Genetically Modified Plants and Animals*, 45 WM. & MARY L. REV. 2167, 2174-76 (2004) (discussing issues of administrative agency inefficiency in the regulation of genetically modified products); Abramowicz, *supra* note 62, at 147 (discussing critiques of rewards system efficiency due to potential agency capture and undue executive influence).

A rewards system will also create other varieties of cost savings. Promoting greater environmental innovation will likely produce administrative savings in other areas—various environmental regulations will become easier to administer and enforce as a result of environmental innovation for instance. A rewards system will help reduce redundant research, as firms will no longer have to invent around competing firms' patents.⁹¹ A patent rewards system also will eliminate the deadweight loss created by traditional patent monopolies.⁹² In addition, the rewards system will reduce licensing transaction costs, and the risks and costs of patent thickets.⁹³ On all the foregoing bases, the cost of a patent rewards system for environmental innovation should not preclude its implementation.

V. CONCLUSION

A patent rewards system is the most promising intellectual property law reform to produce appropriate greater and more efficient incentives for environmental innovation. A patent rewards system is the only reform that causes the needed shift from compensation based on market profits to compensation based on the social benefit of environmental innovation. Patent rewards will compensate inventors for the full environmental benefits of their inventions, and therefore will properly place compensation in line with social benefit. This achievement will internalize the positive externalities of environmental innovation and will solve the related public good problem, achieving the optimal level of incentive to invent, disclose, and commercialize environmental innovation.

Other proponents of patent rewards systems have noted that, despite the potential for increasing social welfare, implementation remains unlikely because rewards systems represent a more radical patent law shift than may be politically achievable.⁹⁴ The rewards system for environmental innovation proposed in this Article, however, provides only an incremental change—implementing rewards solely for certain technological subject matter—and it would preserve inventor autonomy to choose the system they prefer. Consequently, this proposal should be less politically charged and more salient than an apparent overhaul of the patent system. Given that there likely will be some resistance to a rewards system, both from special interests (such as, perhaps, the patent bar)⁹⁵ and due to a status quo bias,⁹⁶ it is logical to start with a limited change in an area that is most likely to produce the most significant benefits. Environmental innovation meets this requirement as it provides benefits not only in reducing deadweight loss, transactions costs, and patent thicket inefficiency, but also through producing potentially vast positive externalities as a result of environmental innovation with widespread health, environmental, and societal benefit.

⁹¹ Abramowicz, *supra* note 62, at 126.

⁹² *Id.*

⁹³ *Supra* notes 49, 79 and accompanying text.

⁹⁴ Abramowicz, *supra* note 62, at 211-12.

⁹⁵ *Id.*

⁹⁶ See Gregory Mandel, *Technology Wars: The Failure of Democratic Discourse* (forthcoming 2005) (describing the *status quo* bias).