PLACING A GLOVE ON THE INVISIBLE HAND: HOW INTELLECTUAL PROPERTY RIGHTS MAY IMPEDE INNOVATION IN ENERGY RESEARCH AND DEVELOPMENT (R&D)

*Dr. Benjamin K. Sovacool**

ABSTRACT

Contrary to the impassioned view that strong intellectual property rights always spur innovation, this Article focuses on how a host of intellectual property barriers may impede the diffusion of renewable energy technologies, clean coal systems, and alternative vehicles. High transaction costs, legal and structural problems at the U.S. Patent and Trademark Office, cognitive biases, anti-competitive patent techniques, and disintegrating government-university-industry partnerships can prevent the innovation and diffusion of clean energy technologies. Quick and decisive action may be warranted to overcome these barriers if greenhouse gas reducing energy systems are to reach commercialization.

* Dr. Benjamin K. Sovacool is currently a Research Fellow in the Energy Governance Program at the Centre on Asia and Globalization, part of the Lee Kuan Yew School of Public Policy at the National University of Singapore. He is an Adjunct Assistant Professor at the Virginia Polytechnic Institute & State University in Blacksburg, VA, where he has taught for the Government and International Affairs Program and the Department of History. Dr. Sovacool recently completed work on a grant from the National Science Found ation's Electric Power Networks Efficiency and Security Program investigating the social impediments to distributed and renewable energy systems. He has also consulted for the Virginia Center for Coal and Energy Research, New York State Energy Research and Development Authority, Oak Ridge National Laboratory, and U.S. Department of Energy's Climate Change Technology Program. His most recent book is an edited volume entitled *Energy and American Society—Thirteen Myths*, published by Springer in 2007. He holds a Ph.D in Science & Technology Studies from the Virginia Polytechnic Institute & State University, an M.A. in Rhetoric from Wayne State University, and a B.A. in Philosophy from John Carroll University. Email: bsovacool@nus.edu.sg.

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INTRODUCTION

At first glance, it may appear that highly developed economies, such as the United States offer many opportunities for inventors, managers, investors, and entrepreneurs wishing to market innovative energy technologies. With relatively few restrictions on trade, robust private capital sector, strong protection of property rights, and limited nationalization of energy industries, the country boasts a remarkably well-functioning energy marketplace. Relative to the developing world, American markets are much more adept at absorbing new technologies, driven by seemingly rigorous investment and individual economic interest. Thomas Casten notes that successful electricity markets "work magic, enticing multiple suppliers to continuously innovate in hopes of gaining profits and market share."[1]

Contrary to this commonly held view, economists and energy analysts have revealed a host of market barriers and failures in the energy sector that can impede innovation and prevent economic efficiency. Commonly discussed market failures include the "principal-agent problem," information asymmetries, "distortionary fiscal and regulatory policies," "unpriced costs" and externalities, and inefficient competition among suppliers.[2] For example, unpriced costs, such as costs associated with greenhouse gas emissions and pollution that are not included in the price of fossil fuel, and perceived inefficient returns on investment deter many homeowners and industries from promoting more energy efficient technologies.[3] Uncertainties concerning the future of energy prices and tax advantages prevent investors from committing to renewable energy projects.[4]

1 Benjamin K. Sovacool, The Power Production Paradox: Revealing the Socio-Technical Impediments to Distributed Generation Technologies 134 (Apr. 17, 2006) (unpublished Ph.D. dissertation, Virginia Polytechnic Institute & State University) (on file with author) [hereinafter The Power Production Paradox] (quoting Interview with Tom Casten, Chair and Chief Executive Officer, Primary Energy (Oct. 5, 2005)).

2 *E.g.*, Marilyn A. Brown, *Market Failures and Barriers as a Basis for Clean Energy Policies*, 29 ENERGY POL'Y 1197, 1199–1201 (2001) (discussing the factors that cause less than optimal investment in efficient energy technologies).

3 *See id.* at 1200–02.

4 Benjamin Sovacool, *Why Has There Been a Relative Failure of Renewable Energy Systems in the USA?*, *in* RENEWABLE ENERGY 2006 24, 26–27 (David Flin ed., 2006); *see also* Sudhakar Reddy & J.P. Painuly, *Diffusion of Renewable Energy Technologies—Barriers and Stakeholder Perspectives*, 29 RENEWABLE

Inadequate standardization and regulatory uncertainty complicate local efforts to deploy small-scale and distributed cogeneration technologies.[5] A short-term focus among private energy firms at making profits makes it difficult to craft an energy policy committed to the deployment of greenhouse gas reducing technologies.[6] Other barriers, such as misplaced incentives and a lack of public consensus, further complicate these impediments.[7]

Even though analysts have done a remarkable job generating a list of market barriers, failures, and impediments, their taxonomy remains incomplete by overlooking a subtle, more persistent (albeit variable) impediment: intellectual property rights. A debate has begun in the biotechnology, pharmaceutical, semiconductor, and software industries over the role of intellectual property in innovation, but such a controversy has all but been ignored by the energy policy literature. In the rare instances when intellectual property concerns are discussed, they are done so either as a technique for measuring the success of a given research and development (R&D) laboratory or institution, or as a needed mechanism to induce technological innovation.

Studies on patents and intellectual property rights, for instance, continue to center mainly on indicators that measure activity rather than quality. Information, such as the number of

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ENERGY 1431, 1432, 1437–38, 1441, 1444–45 (2004) (discussing the results of a survey administered to energy industry representatives, policy experts, households, and businesses in India to determine barriers preventing the diffusion of solar and wind technologies); J.P. Painuly, *Barriers to Renewable Energy Penetration; A Framework for Analysis*, 24 RENEWABLE ENERGY 73, 79–81 tbl.1 (2001) (discussing barriers to investment in renewable energy technologies).

[5] *See* Richard F. Hirsh & Benjamin K. Sovacool, *Technological Systems and Momentum Change: American Electric Utilities, Restructuring, and Distributed Generation Technologies*, 32 J. TECH. STUD. 72, 81 (2006), *available at http://scholar.lib.vt.edu/ejournals/JOTS/v32/v32n2/pdf/hirsh.pdf*; Benjamin K. Sovacool & Richard F. Hirsh, *Energy Myth Six—The Barriers to New and Innovative Energy Technologies Are Primarily Technical: The Case of Distributed Generation (DG)*, *in* ENERGY AND AMERICAN SOCIETY—THIRTEEN MYTHS 145, 156–59 (Benjamin K. Sovacool & Marilyn A. Brown eds., 2007).

[6] *See* INTERLABORATORY WORKING GROUP ON ENERGY-EFFICIENT AND LOW-CARBON TECHNOLOGIES, SCENARIOS OF U.S. CARBON REDUCTIONS: POTENTIAL IMPACTS OF ENERGY-EFFICIENT AND LOW-CARBON TECHNOLOGIES BY 2010 AND BEYOND 2.14 (1997), *available at* http://www.ornl.gov/~webworks/cpr/rpt/95134.pdf.

[7] FLORENTIN KRAUSE & JOSEPH ETO, LEAST-COST UTILITY PLANNING HANDBOOK FOR PUBLIC UTILITY COMMISSIONERS, VOL. II, at II-5, II-7, II-9 (National Association of Regulatory Utility Commissioners 1988).

cooperative research and development agreements (CRADAs) implemented measure the frequency of such transactions, but tell us nothing about their performance, outputs, or outcomes.[8] The idea that strong intellectual property rights induce innovation is deeply embedded in American history, culture, and law. The basis for patent rights lies explicitly in the U.S. Constitution, which states that "[t]he Congress shall have Power . . . [t]o promote the Progress of Science and useful Arts, by securing for limited Times to . . . Inventors the exclusive Right to their . . . Discoveries."[9] The patent system was formally established with the Patent Act of 1790, under which the Secretary of State, Secretary of War, and Attorney General constituted a board that considered all patent applications.[10] More recently, the Supreme Court has emphasized that strong patents are needed to "(1) reward[] invention; (2) stimulat[e] further innovation by promoting the disclosure of inventions; and (3) assur[e] that ideas in the public domain remain there."[11]

In contrast, this Article argues that such thinking may be oversimplified. Based on roughly two dozen research interviews with energy experts (see Appendix A), and an extensive review of the legal and policy research on innovation in other sectors of the economy, this Article suggests that the relationship between intellectual property and innovation is far from straightforward.[12] To make this argument, the Article proceeds as follows:

Part I briefly defines "intellectual property" and "intellectual property rights" before assessing some of the major laws and regulations affecting energy innovation and research and development in the past thirty years. Special emphasis is placed on the changes induced by the 1980 Stevenson-Wydler Technology Innovation Act[13] and the 1980 Bayh-Dole Act.[14]

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[8] SYLVIA KRAEMER, SCIENCE AND TECHNOLOGY POLICY IN THE UNITED STATES: OPEN SYSTEMS IN ACTION 88 (2006).

[9] U.S. CONST. art. I, § 8, cl. 8.

[10] Patent Act, ch. 7, § 1, 1 Stat. 109–10 (1790).

[11] Amy L. Magas, Comment, *When Politics Interfere With Patent Reexamination*, 4 J. MARSHALL REV. INTELL. PROP. L. 160, 160 (2004) (citing Aronson v. Quick Point Pencil Co., 440 U.S. 257, 262 (1979)).

[12] Literature is drawn from other fields for two reasons: extensive debates on intellectual property have not yet occurred in the energy sector and many of the anti-competitive practices concerning new energy technologies, such as submarine patents and suppression, are still secret, making direct analysis of them difficult.

[13] Stevenson-Wydler Technology Innovation Act of 1980, 15 U.S.C. § 3701

Part II explores structural barriers related to intellectual property rights and innovation that arise naturally in market transactions. These include the perception of onerous intellectual property hurdles that prevent collaboration as well as high transaction costs, cognitive bias among researchers, low returns on energy related intellectual property, and problems within the government licensing and reporting process.

Part III investigates intentional, anticompetitive patent techniques, as well as impediments related to regional and international cooperation. These include patent manipulation through techniques, such as warehousing (owning the patent to a novel energy technology but never developing that technology) and suppression (refusing to file for a patent so that a novel process or product never reaches the market). Far deeper barriers relate to a growing concern among academics about applying for patents, as well as some rare, but important negative perceptions between businesses and national laboratories regarding collaboration and CRADAs.

Part IV analyzes possible solutions. Cross licenses and organizational reforms at the U.S. Patent and Trademark Office could reduce transaction costs. Nonexclusive and compulsory licensing, along with the pre-publication of patent applications, patent pools, and the requirement for suppressed technologies to be justified, could reduce the incidence of anticompetitive patent behavior.

Unearthing the intellectual property barriers to innovative energy technologies is important for at least four reasons. First, rising energy demand coupled with stagnating supply, growing volatility of energy markets, increasing dependence on foreign supplies of fuel, a degrading electric transmission and distribution grid, and continually mounting environmental costs of energy production and consumption demand a robust and sustained research strategy on energy technologies.[15] Almost every step in the process of converting fossil fuel into electricity—including mining, cooling, waste stream management, and emissions—damages human health and the environment, and distributes these impacts unevenly on the nation's young, poor,

(1980).

[14] Bayh-Dole Patent and Trademark Laws Amendment Act, Pub. L. No. 96-517, 94 Stat. 3015 (1980).

[15] Marilyn A. Brown, Benjamin K. Sovacool & Richard F. Hirsh, *Assessing U.S. Energy Policy*, DAEDALUS: J. AM. ACAD. ARTS & SCI., Summer 2006, at 5–11.

and elderly.[16] As Stephen Chu, Director of the Lawrence Berkeley National Laboratory, succinctly stated, "the energy problem is *the single most important problem* that has to be solved by science and technology in the coming decades."[17] The diffusion of clean energy technologies is thus one of the most significant challenges facing society.

Second, intellectual property barriers affect both old and new technologies. While strong intellectual property protections can impede the growth of new energy technologies, such as horizontal axis wind turbines, hydrogen fuel cells, and carbon capture and sequestration systems, they also prevent the diffusion of many older and more conventional clean energy systems and practices. Compact fluorescent light bulbs and more efficient industrial boilers continue to face many of the same barriers as newer technologies. Thus, overcoming such obstacles may be essential for advancing *all* types of energy technology, not just new, novel, and radical ideas and systems.

Third, if intellectual property barriers truly impede the diffusion of clean energy systems, then attempts to promote the technological development of such technologies will remain insufficient until policymakers address such barriers. An examination of intellectual property impediments is essential if firms and researchers working in the energy sector can learn from and avoid mistakes made in the biotechnology, software, and pharmaceutical industries, where strong patent rights can inflate costs and prevent market entry. Given the growing costs of climate change, the lessons concerning intellectual property gleaned from these other sectors of the economy may be instrumental in devising more effective deployment strategies for cleaner technologies.

Fourth, an assessment of the relationship between strong intellectual property rights and energy R&D offers a useful tool

[16] Benjamin K. Sovacool & Christopher Cooper, *Green Means 'Go?'—A Colorful Approach to a U.S. National Renewable Portfolio Standard*, 19 ELECTRICITY J. 19, 28 (2006). For a good introduction assessing the environmental dimensions of energy production in the United States, see INTERLABORATORY WORKING GROUP ON ENERGY-EFFICIENT AND CLEAN-ENERGY TECHS., SCENARIOS FOR A CLEAN ENERGY FUTURE (2000), *available at* http://www.ornl.gov/sci/eere/cef/.

[17] *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future: Testimony Before the H. Comm. on Science*, 109th Cong. (2006) (statement of Steven Chu, Director, Lawrence Berkeley National Laboratory), *available at* http://gop.science.house.gov/hearings/full06/March%209/Chu.pdf.

for re-conceptualizing the current landscape of innovation. While numerous stakeholders have traditionally been involved in technology transfer and the creation of intellectual property statutes, three spheres have recently emerged to become dominant arenas: the country's approximately 14,000 industrial R&D laboratories, approximately 730 government laboratories, and approximately 1,270 university research facilities.[18] These new actors create a "triple helix" of resources and capital formation that facilitates non-linear, interactive technical development that is radically altering the contemporary R&D climate.[19] Debates over intellectual property can also be interpreted as conflicts over how corporate, academic, and civic cultures view technology and the R&D process. Such clashes have the tendency to reveal shifting conceptions of ownership, authorship, and invention, as well as changes in the organization of innovation and the production and diffusion of technology.

I. CONCEPTUALIZING INTELLECTUAL PROPERTY AND INTELLECTUAL PROPERTY RIGHTS

Intellectual property (IP), by its very nature, is intangible. The consumption of normal, or tangible property, is rivalrous. George Bernard Shaw made this distinction when he remarked:

> If you have an apple and I have an apple and if we exchange these apples then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas.[20]

Thus, IP does not share the same feature of excludability that

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[18] Marilyn A. Brown, U.S. National Laboratory Perspective on Energy Technology Innovation and Performance Assessment, International Conference on Innovation in Energy Technologies, September 29–30, 2003, http://www.oecd.org/dataoecd/3/35/15935294.pdf.

[19] *See generally* Henry Etzkowitz, *Innovation in Innovation: The Triple Helix of University-Industry-Government Relations*, 42 SOC. SCI. INFO. 293 (2003); Henry Etzkowitz, *Incubation of Incubators: Innovation as a Triple Helix of University-Industry-Government Networks*, 29 SCI. & PUB. POL'Y 115 (2002); *see also* Henry Etzkowitz et al., *The Future of the University and the University of the Future: Evolution of Ivory Tower to Entrepreneurial Paradigm*, 29 RES. POL'Y 313, 313–14, 327 (2000); Henry Etzkowitz, & Loet Leydesdorff, *The Future Location of Research and Technology Transfer*, 24 J. TECH. TRANSFER 111, 111–13 (1999).

[20] Rosemary Chalk, *Overview: AAAS Project on Secrecy and Openness in Science and Technology*, 10 SCI., TECH., & HUM. VALUES 28, 28 (1985) (quoting A.I. MIKAILOV, A.I. CHERNYI & R.S. GILIAREVSKII, SCIENTIFIC COMMUNICATION AND INFORMATION 39 (Robert H. Burger trans., Information Resources Press 1984)).

tangible property does. The fundamental assumption is that without IP protections (or without affording people exclusive rights to intangible property), there is no incentive (financial or otherwise) to create new inventions.

In the United States, IP is generally classified into one of six areas:

Copyrights protect the original expression of an idea (creative and artistic works), affording the owner exclusive control to reproduce or adapt such works for a certain period of time.[21] Legal protection is offered instantly and when subject matter is fixed into tangible form (e.g. paper or digital storage).[22] Copyrights are typically valid for the author's lifetime plus seventy years.[23]

Patents are granted for new, useful, and non-obvious inventions, and give the patent holder the exclusive right to commercially exploit the invention for a specified time period (usually twenty years).[24] Patents are intended to protect functional concepts, methods, or processes.[25] In the U.S., the "first-to-invent" system applies, while much of the rest of the world subscribes to the "first to file" system.[26]

Trademarks and *industrial design rights* refer to distinctive signs used to demarcate the products of different businesses, and are intended to protect distinctive marks and ornamental designs.[27] Such protections have proven very useful in industries such as automobiles and clothing.[28]

Trade secrets refer to confidential or non-public information concerning commercial practices or proprietary knowledge of a business.[29]

Geographical indications certify that a consumer product

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21 ARTHUR R. MILLER & MICHAEL H. DAVIS, INTELLECTUAL PROPERTY: PATENTS, TRADEMARKS, AND COPYRIGHT IN A NUTSHELL 292–93 (3d ed. 2000).

22 *Id.* at 292 (citing 17 U.S.C.A. § 102(a)).

23 *Id.* (citing 17 U.S.C.A. § 302(a)).

24 *Id.* at 10, 12 (citing 35 U.S.C.A. §§ 101, 154).

25 *Id.* at 20, 22.

26 Behfar Bastani & Dennis Fernandez, *Intellectual Property Rights in Nanotechnology*, 420–21 THIN SOLID FILMS 472, 473 (2002).

27 MILLER & DAVIS, *supra* note 21, at 164–65; WIPO, INTELL. PROP. FOR BUS. SERIES NO. 2, LOOKING GOOD: AN INTRODUCTION TO INDUSTRIAL DESIGNS FOR SMALL AND MEDIUM-SIZED ENTERPRISES 3 (2006), *available at* http://www.wipo.int/freepublications/en/sme/498/wipo_pub_498.pdf.

28 *See* WIPO, *supra* note 27, at 3 (noting the relevance of industrial design rights to a variety of industries including fashion and cars).

29 ROGER E. SCHECHTER & JOHN R. THOMAS, INTELLECTUAL PROPERTY: THE LAW OF COPYRIGHTS, PATENTS AND TRADEMARKS 3 (2003).

(wine, spirits, foodstuffs, etc.) were made in a particular place and "possess qualities or a reputation that are due to that place of origin."[30]

Various forms of *sui generis* protection apply to inventions that do not easily fit into existing classifications.[31]

At their most basic level, *intellectual property rights* (IPR) are negative in nature, setting exclusive rights to particular parties and excluding others from infringing on their monopoly.[32] Such exclusive rights can be generally transferred, licensed (a rent on the property), or mortgaged to third parties.[33] Such licenses are typically divided into two categories: those that grant exclusive rights only on copying or reproducing an item, and those that grant a right to prevent others from infringing on an idea.[34]

Markets for inventions that embody intellectual investments are characterized by an externality known as the "public goods problem." Public goods are considered to be nonexcludable because it is difficult to prevent "free riders"—those who do not pay for the goods—from consuming them. Public goods are also subject to nonrivalrous competition in that additional consumers of the goods will not deplete the supply available to others. Private markets tend to undersupply public goods because producers cannot reap the marginal value of their investment in providing them.[35]

The economic rationale for the patent system is intended to correct such challenges by (1) providing a system of incentives

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[30] WIPO, Geographic Indications, http://www.wipo.int/about-ip/en/geographical_ind.html (last visited Mar. 2, 2008).

[31] *See* Lee Davis, *Intellectual Property Rights, Strategy and Policy*, 13 ECON. INNOVATION NEW TECH. 399, 401, 404 (2004) (discussing novel forms of *sui generis* rights applied to the computer chip industry and the information processing industry in the U.S. and E.U., respectively); *see also* SCHECHTER & THOMAS, *supra* note 29, at 2 (citing Semiconductor Chip Protection Act, Pub. L. No. 98-6209, 98 Stat. 3347 (1984); Audio Home Recording Act, Pub. L. No. 92-140, 85 Stat. 391 (1971)) (introducing rights associated with copyright protection in the semiconductor and digital audio industries); Bastani & Fernandez, *supra* note 26, at 473 (describing "maskworks" as another type of IP protection).

[32] SCHECHTER & THOMAS, *supra* note 29, at 5.

[33] *See id.* at 105, 111–12, 770, 779 (stating that trademarks are transferable and can be licensed, and copyrights are transferable and can be lost through foreclosure on a mortgage).

[34] RICHARD S. GRUNER ET AL., INTELLECTUAL PROPERTY IN BUSINESS ORGANIZATIONS: CASES AND MATERIALS 1042 (2006).

[35] Kurt M. Saunders, *Patent Nonuse and the Role of Public Interest as a Deterrent to Technology Suppression*, 15 HARV. J.L. & TECH. 390, 397 (2002).

and rewards, so that competitors can no longer exploit the free-rider phenomenon, and (2) rewarding creators and incentivizing them to produce a variety of wider works that the public may be willing to pay for, stimulating creativity, giving the consumer more choices, and creating new markets.[36] The theory of intellectual property rests on a fundamental argument about markets: if competitors can successfully copy inventions without having to share in the initial costs and risks of making them, inventing firms are always at a disadvantage.[37] Free copying would reduce the price consumers pay, but it would also reduce the incentive to make new inventions.[38] Thus, we endure monopoly pricing of new inventions for a limited time to create an incentive to invent.[39] Patents represent a balancing of society's interest in promoting free competition against its interest in encouraging innovation by rewarding inventors.

Four broad rationales concerning the importance of patents are often distinguished:

"*[I]nvention motivation*;" "[t]he anticipation of patents provides motivation for useful invention" so that the significant resources and risk involved in developing an invention are overcome.

"*Inducement of commercialization*;" patents are needed to induce investments to develop and commercialize inventions. Typically, one commercial product is in mind.

"*Information disclosure*;" patents are needed to persuade inventors to disclose and declare their inventions to society.

"*Exploration control*;" "patents enable the orderly exploration of a broad prospect". The initial discovery is not intended to produce a particular product, but is instead seen as opening up a wide range of follow in developments.[40]

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[36] Kurt M. Saunders & Linda Levine, *Better, Faster, Cheaper—Later: What Happens When Technologies Are Suppressed*, 11 MICH. TELECOMM. & TECH. L. REV. 23, 38 (2004) (citing F.M. SCHERER, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 440 (2d ed. 1980)).

[37] *See id.* at 44 (citing WILLIAM G. SHEPHERD, THE ECONOMICS OF INDUSTRIAL ORGANIZATION 145–46 (1990)) (discussing the idea that without monopoly protection inventors lose profits through imitation).

[38] *See id.*

[39] *Id.* (citing WILLIAM G. SHEPHERD, THE ECONOMICS OF INDUSTRIAL ORGANIZATION 145–46 (1990)); Jock Langford, *Intellectual Property Rights: Technology Transfer and Resource Implications*, 79 AM. J. AGRIC. ECON. 1576, 1576 (1997).

[40] Roberto Mazzoleni & Richard R. Nelson, *The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate*, 27 RES. POL'Y 273, 274–75, 279 (1998).

Because of such reasoning, the federal government has exhibited strong support for IPR in recent years. In the 1970s, "[i]nflation was high, the stock market was low," and officials believed that federal laboratories harbored information that was not being disseminated to those who could make use of it.[41] Scores of "different federal agencies disposed of patent rights to government-funded research in twenty-six different ways," resulting in "confusion, frustration, and stagnation."[42] Similarly, concern heightened that "advances attributable to university-based research were not being pursued because there was little incentive to seek practical uses for inventions to which the federal government retained title."[43] Strong IPR protection was intended to "ensure effective transfer and commercial development of discoveries that would otherwise languish in government and university archives."[44] It was also needed to "reinvigorate U.S. industry by giving it a fresh infusion of new ideas . . . " thus creating jobs and enhancing economic productivity.[45] And it was believed to "ensure that U.S.-sponsored research discoveries were developed by U.S. firms, rather than by foreign competitors . . . "[46]

In response, the federal government has passed a number of important laws and regulations relating to IPR (See Table 1). The most important of these were the Stevenson-Wydler Technology Innovation Act of 1980 and Bayh-Dole Patent and Trademark Laws Amendment Act of 1980, which enabled universities and small businesses (later extended to virtually all businesses) to enter into CRADAs with government laboratories and to use public resources to patent discoveries.[47]

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[41] Chester G. Moore, Comment, *Killing the Bayh-Dole Act's Golden Goose*, 8 TUL. J. TECH. INTELL. PROP. 151, 151–52 (2006) (citing H.R. REP. NO. 96-1307, pt. 1, at 5 (1980), *as reprinted in* 1980 U.S.C.C.A.N. 6460, 6464; *Innovation's Golden Goose*, ECONOMIST, Dec. 14, 2002, at 3, 3).

[42] *Id.* at 153 (citing H.R. REP. NO. 96-1307, pt. 1, at 3 (1980), *as reprinted in* 1980 U.S.C.C.A.N. 6460, 6462; Bradley Graham, *Patent Bill Seeks Shift to Bolster Innovation; Patent Ownership Question Heats up Again*, WASH. POST, Apr. 8, 1979, at M1).

[43] RES., CMTY, & ECON. DEV. DIV., U.S. GEN. ACCOUNTING OFFICE, GAO/RCED-98-126, TECHNOLOGY TRANSFER: ADMINISTRATION OF THE BAYH-DOLE ACT BY RESEARCH UNIVERSITIES 3 (1998).

[44] Rebecca S. Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research*, 82 VA. L. REV. 1663, 1664 (1996).

[45] *Id.* at 1664–65.

[46] *Id.* at 1665.

[47] Stevenson-Wydler Technology Innovation Act of 1980, 15 U.S.C. § 3710a

Table 1: Important Federal Government Action Concerning Intellectual Property Rights and Patents

Year	Act	Description
1945	National Patent Planning Commission	Proposed that federal agencies be permitted to set separate policies regarding their technology.[48]
1947	U.S. Department of Justice Investigation of Government Policies and Practices	"Urged adoption of uniform policy in which the government took title to almost all federally funded technologies."[49]
1950	Executive Order 10096	"Established centralized Government Patent Board to decide upon patent ownership."[50]
1961	Executive Order 10930	"Allowed [federal] agencies to set separate patent policies, and to sometimes grant nonexclusive licenses."[51]
1980	Stevenson-Wydler Technology Innovation Act (PL 96-480)	Established technology transfer as "a mission of federal laboratories," permitted inventions owned by the government to remain the property of the agencies that produced them, required agencies to create Offices of Research and Technology Applications.[52]

(2008); Bayh-Dole Act, 35 U.S.C. §§ 200, 202 (2008).

[48] Adam B. Jaffe & Josh Lerner, *Reinventing Public R&D: Patent Policy and the Commercialization of National Laboratory Technologies*, 32 RAND J. ECON. 167, 172 (2001) (citing Lewis M. Branscomb, *National Laboratories: The Search for New Missions and New Structures*, *in* EMPOWERING TECHNOLOGY: IMPLEMENTING A U.S. STRATEGY 103, 104, 113 (Lewis M. Branscomb ed., 1993); U.S. GEN. ACCOUNTING OFFICE, GAO/RCED-98-197, DEP'T OF ENERGY: UNCERTAIN PROGRESS IN IMPLEMENTING NATIONAL LABORATORY REFORMS (1998), *available at* http://www.globalsecurity.org/wmd/library/report/gao/rc98197.pdf; OFFICE OF TECH. ASSESSMENT, CONGRESS OF U.S., OTA-ITE-552, DEFENSE CONVERSION: REDIRECTING R&D (1993), *available at* http://govinfo.library.unt.edu/ota/Ota_1/DATA/1993/9318.PDF).

[49] *Id.*

[50] *Id.*

[51] *Id.*

[52] Robert M. Margolis & Daniel M. Kammen, Evidence of Under-Investment

1980	Patent and Trademark Laws Amendment (Bayh-Dole) Act (PL 96-517)	Focused on government inventions created under federal contracts, grants, and cooperative research and development agreements, and permitted nonprofit organizations such as universities to retain title and market the inventions they created using federal funds.[53]
1984	Trademark Clarification Act (PL 98-620)	"Granted broader authority to directors of government-owned, contractor-operated (GOCO) laboratories . . . ,"[54] by extending many, but not all, of the Bayh-Dole provisions to them.[55]
1986	Federal Technology Transfer Act (PL 99-502)	Amended Stevenson-Wydler to allow government owned, government operated laboratories to enter into cooperative research and development agreements (laboratories only allowed to provide materials and personnel, not direct funding), and permitted federal employees to receive a share of royalties from the licenses of their inventions.[56]
1989	National Competitiveness Technology Transfer Act (PL 101-189)	Amended Stevenson-Wydler to allow government owned, contractor operated laboratories to enter into cooperative research and

in Energy R&D in the United States and the Impact of Federal Policy, 27 ENERGY POL'Y 575, 581 tbl.2 (1999); David H. Guston, Technology Transfer and the Use of CRADAs at the National Institutes of Health, *in* INVESTING IN INNOVATION: CREATING A RESEARCH AND INNOVATION POLICY THAT WORKS 221, 223 (Lewis M. Branscomb & James H. Keller eds., 1998) [hereinafter Technology Transfer]; *see also* David H. Guston, *Stabilizing the Boundary Between US Politics and Science: The Role of the Office of Technology Transfer as a Boundary Organization*, 29 SOC. STUD. SCI. 87, 94 (1999) [hereinafter *Stabilizing the Boundary*].

[53] Margolis & Kammen, *supra* note 52, at 581 tbl.2; *Technology Transfer*, *supra* note 52, at 223; *Stabilizing the Boudnary*, *supra* note 52, at 94–95.

[54] Margolis & Kammen, *supra* note 52, at 581 tbl.2.

[55] *Stabilizing the Boundary*, *supra* note 52, at 95.

[56] Margolis & Kammen, *supra* note 52, at 581 tbl.2.

		development agreements, and "[e]xtended authority to [government-owned, contractor-operated laboratories] to fully engage in cooperative research, i.e., sharing facilities, personnel and funding . . . ."[57]
1992	Defense Conversion, Reinvestment, and Transition Assistance Act (PL 102-484)	Made "statutory changes . . . to foster the transfer of technology . . . into the private sector.[58]
1993	National Cooperative Production Amendments of 1993 (PL 103-42)	Ensured that firms entering into R&D ventures did not violate antitrust statutes.[59]
1995	National Technology Transfer and Advancement Act of 1995 (PL 104-113)	Amended Stevenson Wydler to allow non federal partners to choose exclusive or nonexclusive licenses for CRADA inventions, and the government to require a partner to grant third party licenses to meet exceptional public health or safety needs, to meet federal requirements, if the partner failed to comply with the agreement, or to support further federal research.[60]
1999	American Inventors Protection Act of 1999 (PL 106-113)	Requires patent applications to be open for public inspection 18 months after the filing date.[61]
2000	Technology Transfer Commercialization Act (PL 106-404)	Expanded the scope of what can be licensed under CRADAs and improved the ability of CRADAs to license inventions created in federal

[57] *Id.*

[58] Adam B. Jaffe, Michael S. Fogarty & Bruce A. Banks, *Evidence from Patents and Patent Citations on the Impact of NASA and Other Federal Labs on Commercial Innovation*, 46 J. INDUS. ECON. 183, 184 (1998).

[59] National Cooperative Production Amendments of 1993, Pub. L. No. 103-42, 107 Stat. 117.

[60] National Technology Transfer and Advancement Act of 1995, Pub. L. No. 104-113, § 4, 110 Stat. 775, 775–76.

[61] American Inventors Protection Act of 1999, Pub. L. No. 106-113, §§ 4001, 4502(a), 113 Stat. 1501, 1501A561.

		facilities.[62]
2005	Energy Policy Act (PL 109-58)	Established a Technology Transfer Coordinator for the U.S. Department of Energy to emphasize commercialization at its national laboratories.[63]

II. STRUCTURAL AND ECONOMIC BARRIERS RELATED TO IPR AND INNOVATION

However, despite such consistent government support, patents have the potential to invariably create thin markets for technological innovation, since they essentially create a bilateral monopoly between the seller and a single buyer. Therefore, markets that involve patents are "not a propitious environment for the emergence of prices that will sustain an efficient allocation of resources . . . "[64] Moreover, since transactions in knowledge always riddled with "leakages," "for an exchange to be conducted efficiently both parties need to know the characteristics of the commodity being transacted, which, in the case of information, can hardly be done in a complete way without vitiating the purpose of the transaction itself."[65]

The case can be made that allowing industry and university partners to retain title over publicly funded research impedes the disbursement of new technology because "allowing private firms to hold exclusive rights to inventions that have been generated at public expense . . . seems to require the public to pay twice for the same invention—once through taxes . . . and then again through higher monopoly prices and restricted supply when the invention reaches the market."[66] When the Bayh-Dole Act was

[62] U.S. GEN. ACCOUNTING OFFICE, GAO-03-47, INTELLECTUAL PROPERTY: FEDERAL AGENCY EFFORTS IN TRANSFERRING AND REPORTING NEW TECHNOLOGY (2002), *available at* http://www.gao.gov/new.items/d0347.pdf (citing Technology Transfer Commercialization Act of 2000, Pub. L. No. 106-404, 114 Stat. 1742).

[63] Energy Policy Act of 2005, Pub. L. No. 109-58, § 1001, 119 Stat. 594, 926 (codified at 42 U.S.C. § 16391).

[64] Paul A. David & Dominique Foray, *Accessing and Expanding the Science and Technology Knowledge Base*, 16 STI REV. 13, 30–31 (1995) (citing Kenneth J. Arrow, *Political and Economic Evaluation of Social Effects and Externalities*, *in* FRONTIERS OF QUALITATIVE ECONOMICS (M. Intriligator ed., 1971)).

[65] *Id.* at 31–32.

[66] Eisenberg, *supra* note 44, at 1666.

initially debated, Admiral Hyman Rickover and Representative Jack Brooks both spoke out against the bill "as a giveaway of public property."[67]

Furthermore, such practices may contravene the conventional wisdom that patent rights on existing inventions result in a net social loss (the initial justification for government R&D for technologies businesses would not promote). "[P]romoting the private appropriation of federally-sponsored research . . . calls into question the public goods rationale for public funding of research. . . . [P]roviding incentives to patent and restrict[ing] access . . . threatens to impoverish the public domain of research science that has long been an important resource for [scientists]."[68] This new vision of federal research equates public ownership with what Rebecca Eisenberg called "'dead-hand' control," reducing the public domain to "a treacherous quicksand pit in which discoveries sink beyond reach of the private sector."[69]

Such impediments can become especially acute given a litany of IP barriers, such as high transaction costs and a resulting bias against small firms, cognitive dispositions among researchers, low returns on energy-related IPR investments, structural problems at the U.S. Patent and Trademark Office, and concerns about anti-trust suits for firms that cooperate.

A. High Transaction Costs

The first—and most obvious—transaction cost concerning IPR is the expense of filing for the patent itself. The cost of filing a patent is really a series of interrelated expenses, such as conducting a pre-application patent search, review of the product's patentability, preparation of formal drawings, filing fees with the U.S. Patent and Trademark Office (USPTO), and patent attorney fees.[70] While the transaction costs associated with patent filing will vary depending on the type of technology

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[67] Moore, *supra* note 41, at 154 (citing H.R. REP. NO. 96-1307, at 22 (1980), *as reprinted in* 1980 U.S.C.C.A.N. 6492, 6511–12).

[68] Eisenberg, *supra* note 44, at 1667.

[69] *Id.* at 1663–64 (citing *Industrial Innovation and Patent and Copyright Law Amendments: Hearing on H.R. 2414 Before the Subcomm. On Courts, Civil Liberties, and the Administration of Justice of the H. Comm. on the Judiciary*, 96th Cong. 286 (1980) (statement of Howard W. Bremer, Patent Counsel, Wisconsin Alumni Research Foundation)).

[70] Cost of Obtaining a Patent, IP Watchdog.com, http://www.ipwatchdog.com/patent_cost.html (last visited Oct. 2, 2008).

and breadth of the patent, typical costs range anywhere from $10,000 to hundreds of thousands of dollars per patent (See Table 2).

Table 2: Typical Patent Filing Fees for all Inventions[71]

Invention	Search & Report	Attorney Fees	USPTO Fees	Estimate Total
Minimally Complex	$1,000	$7,500	$1,595	$10,095
Moderately Complex	$1,250	$12,500	$1,595	$15,345
Intermediately Complex	$1,500	$17,500	$1,595	$20,595
Relatively Complex	$2,000 +	$20,000 +	$1,595	$23,595 +

Such expenses do *not* include the costs associated with patent continuation, maintenance, and enforcement against infringement. After filing for a patent in the U.S., inventors and firms can expect to expend an additional $20,000 per each foreign country in which patent protection is sought.[72] "Furthermore, the patent filing process typically takes between 24 and 36 months, with patent searches taking between one to two months, application preparation one to two months, prosecution one to two years, and issuance three to nine months."[73] Average pendency for U.S. patents (measured from filing to ultimate disposal) in 2008 is projected to be twenty-seven months.[74]

[71] MARILYN A. BROWN, JESS CHANDLER, MELISSA V. LAPSA & BENJAMIN K. SOVACOOL, CARBON LOCK-IN: BARRIERS TO DEPLOYING CLIMATE CHANGE MITIGATION TECHNOLOGIES 70 (2007), *available at* http://www.ornl.gov/sci/eere/PDFs/ORNLTM-2007-124_rev200801.pdf [hereinafter CARBON LOCK-IN] (citing Cost of Obtaining a Patent, IP Watchdog.com, http://www.ipwatchdog.com/patent_cost.html (last visited Oct. 2, 2008)).

[72] Patents and Other Legal Protection, University of Michigan Techtransfer, http://www.techtransfer.umich.edu/resources/inventors/patents.php (last visited Oct. 2, 2008).

[73] CARBON LOCK-IN, *supra* note 71, at 70.

[74] *See* Carl Shapiro, *Patent System Reform: Economic Analysis and Critique*, 19 BERKELEY TECH. L.J. 1017, 1036 (2004) (citing USPTO, THE 21ST CENTURY STRATEGIC PLAN (2003), *available at* http://www.uspto.gov/web/offices/com/strat21/stratplan_03feb2003.pdf) (noting that the USPTO set the twenty-seven month time period as a goal to be accomplished by 2008).

Second, the increase in the number of patents has contributed to higher transaction costs for collecting information and rearranging entitlements. The U.S. Patent and Trademark Office receives 350,000 patent applications each year and grants around 180,000.[75] Among the 100 U.S. academic institutions with the highest funding, 177 patents were issued in 1974, 196 in 1979, 408 in 1984, 1,004 in 1989, and 1,486 in 1994.[76] The passage of the Bayh-Dole Act, feasibility of biotechnology licensing from "the *Diamond v. Chakrabarty* Supreme Court decision, which opened the door to patenting . . . organisms, molecules, and research techniques," and "the broader shift in U.S. policy to strengthen [IPR]" have resulted in an exponential increase in university patents.[77]

The emergence of an incredibly complex and rapidly changing patent environment creates several barriers to innovation. In several other sectors of the economy—including biotechnology, computer software, and the Internet—the patent system is more like a patent *thicket*, or "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology."[78] Commentators have mused that if the ancient builders of the pyramids had to operate under the current patent system, their project might never have been completed.[79] Unlike the Egyptian labor system, while obviously oppressive but also effective, the patent system as currently structured would be akin to forcing the planners at the top of the pyramid to get permission of every person who previously placed a block at the bottom to complete the project. Such a system would have slowed down construction of the pyramids indefinitely.

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75 A PATENT SYSTEM FOR THE 21ST CENTURY 1, 28 (Stephen A. Merrill et al. eds., 2004).

76 David C. Mowery & Arvids A. Ziedonis, *Numbers, Quality, and Entry: How Has the Bayh-Dole Act Affected U.S. University Patenting and Licensing?*, *in* 1 INNOVATION POLICY AND THE ECONOMY 187, 192 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., 2000).

77 *Id.* at 212; *see also* David C. Mowery, Richard R. Nelson, Bhaven N. Sampat & Arvids A. Ziedonis, *The Growth of Patenting and Licensing by U.S. Universities: An Assessment of the Effects of the Bayh-Dole Act of 1980*, 30 RES. POL'Y 99, 103 (2001).

78 Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION AND THE ECONOMY 119, 119, 120 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., 2000) [hereinafter *Navigating the Patent Thicket*].

79 *See, e.g.*, *id.* at 120.

A survey of thousands of patents between 1963 and 1994 suggested that around "one-fourth [of patent citations] appear to be essentially noise."[80] When intentionally used by companies to block the entry of other firms into an area of business, patents may serve as an even more serious impediment—acting as fences rather than thickets.[81] The Federal Trade Commission noted that such fences can introduce licensing difficulties, especially when royalties are stacked one on top of another, increasing uncertainty about the patent landscape, and frustrating competition for both current manufacturers as well as potential entrants.[82]

As an example of how IP issues can directly delay the commercialization of innovative energy technologies, consider R&D conducted on advanced absorption cycle technologies in the 1980s and 1990s.[83] In 1982, Phillips Engineering began a GAX residential gas-fired absorption heat pump project. By the early 1990s, Phillips had several "laboratory" prototypes, but Phillips refused to license its technology to the Gas Research Institute (GRI). The GRI was convinced that Phillips did not have the expertise to fully commercialize GAX technology, so GRI started a separately funded project with Arctek to develop comparable technology without infringing on Phillips's patents. In 1995, at the strong urging of DOE, Phillips did license the technology, but to an entirely different company—Carrier. Carrier, after considerable additional technical work, decided to abandon the project in late 1996. Arkla/Servel (in Evansville, Indiana), having been purchased by Robur (an Italian company), finally convinced Phillips to license its technology to Robur in the late 1990s. Robur was able to bring GAX products to the European market more than ten years after they had been developed in the U.S.[84]

Ultimately, the complicated patent licensing situation delayed

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80 Adam B. Jaffe, Michael S. Fogarty & Bruce A. Banks, *Evidence from Patents and Patent Citations on the Impact of NASA and Other Federal Labs on Commercial Innovation*, 46 J. INDUS. ECON. 183, 187, 202 (1998).

81 Markus Reitzig, *The Private Values of 'Thickets' and 'Fences': Towards an Updated Picture of the Use of Patents Across Industries*, 13 ECON. INNOVATION NEW TECH. 457, 458 (2004).

82 FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 25 (2003), *available at* http://www.ftc.gov/os/2003/10/innovationrpt.pdf.

83 Interview with Robert C. Devault, Oak Ridge National Laboratory.

84 *Id.*

the introduction of GAX technology to the market and cost perhaps a few million extra R&D dollars.[85] Being manufactured in Italy and exported to the U.S. increases costs to potential American customers. Very few Robur units are sold in the U.S. at the present time. The somewhat complicated GAX saga is a typical example of how multiple patent licensing issues can delay innovation and ultimately drive R&D out of the country.

The GAX example underscores the notion that most public and private institutions have limited resources for absorbing transaction costs and limited competence in fast-paced, market bargaining. Such limited resources make it difficult to harmonize the interests of corporate, laboratory, and university sponsors, and may complicate the emergence of standard licensing terms.[86] "[I]dentifying subsequent inventors before the pioneer commercializes the original invention may prove difficult" and researchers may need to commit significant investment before deciding whether their idea is patentable—something "they may be reluctant to do [ ] since those R&D costs will be sunk before [a project commences]."[87] Higher barriers of entry exist for both smaller and newer firms, a hurdle heightened by the increasing trend for IPR "to be granted on discoveries or procedures that are a long way from practical application," in particular "on what used to be considered as 'science,'" making it extremely difficult to procure reliable information about IPR in a given field.[88]

One review of the energy industry found that a host of greenhouse gas reducing technologies—such as cogeneration and combined heat and power systems, new process schemes, resource efficiency, substitution of materials, recycling, changes in manufacture and design, and fuel switching—remain impeded by high transaction costs for obtaining reliable information.[89]

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85 *Id.*

86 *See* Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 700 (1998) (discussing the transaction costs that hinder "the bundling of intellectual property rights in biomedical research").

87 Nancy T. Gallini, *The Economics of Patents: Lessons from Recent U.S. Patent Reform*, 16 J. ECON. PERSP. 131, 137 (2002).

88 Roberto Mazzoleni & Richard R. Nelson, *The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate*, 27 RES. POL'Y 273, 281 (1998).

89 *See* Ernst Worrell, Rene van Berkel, Zhou Fengqi, Christoph Menke, Roberto Schaeffer & Robert O. Williams, *Technology Transfer of Energy Efficient Technologies in Industry: A Review of Trends and Policy Issues*, 29

"Information collection . . . consumes time and resources," especially for small firms,[90] and many industries may prefer to expend their human and financial capital on other investment priorities. Thus, many industrial managers and decision makers simply do not believe they have enough time or money to research new technologies.[91]

Thomas Casten, who has almost three decades of experience selling cogeneration units to businesses, explains that both large and small manufacturing firms resist undertaking novel energy projects.[92]

The typical manufacturing enterprise focuses its intellectual and financial resources on core activities—making beer, or steel, or chemicals, etc. The vast bulk of industry will not invest in energy plants unless they are 'broken' or, in the best case, when an energy efficiency project will pay back the capital investment in 12 to 18 months. Companies have a much higher investment hurdle rate for core activities than non-core activities, and they employ very few specialists in any non-core activity. This focus on core activities has become the big buzz in management discussions over the last twenty years. Peter Drucker insists that to be successful in a world of globalization, companies must focus on their core mission and outsource all of the non-core functions to specialist firms. In general, this makes sense, and is widely practiced.[93]

Energy projects are often resisted by all levels of the business community because they distract personnel from more profitable ventures. Chris Russel, who studies industrial trends at the nonprofit Alliance to Save Energy (ASE), explains that:

ENERGY POL'Y 29, 34 (2001) (discussing impediments to technology transfer in developing countries).

[90] *Id.* (citing Edelgard Gruber & Michael Brand, *Promoting Energy Conservation in Small- and Medium-Sized Companies*, 19 ENERGY POL'Y 279 (1991); Jan Willem Velthuijsen, Determinants of Investment in Energy Conservation (1995) (unpublished Ph.D. dissertation, SEO, University of Amsterdam, The Netherlands)).

[91] *See* FRANCES CAIRNCROSS, THE COMPANY OF THE FUTURE: HOW THE COMMUNICATIONS REVOLUTION IS CHANGING MANAGEMENT 39 (2002), *available at* http://www.acm.org/ubiquity/book/f_cairncross_1.html (discussing companies preference "to 'buy in' innovation rather than 'making' it all in-house").

[92] Interview with Thomas Casten, Chairman, Recycled Energy Development Corporation (Dec. 2006), *available at* http://gristmill.grist.org/story/2007/8/12/105752/270.

[93] Sovacool, The Power Production Paradox, *supra* note 1, at 83–84 (quoting Interview with Tom Casten, Chairman, Recycled Energy Development Corporation (Oct. 5, 2005)).

Facilities are thinly staffed, running flat out every day to meet production goals. Therefore distractions aren't welcome. For them, routine is a good thing, and their mantra becomes 'that's the way we've always done it.' So when you propose energy [projects for] a facility, you are really proposing changes to the way they operate. You have people in operations, finance, procurement, and engineering—all of whom will be impacted by energy management, and all of whom usually have some reason to resist change [. . . .] Decision makers are continually making a tradeoff between risk, time, and money. If you propose an energy efficiency measure that saves X dollars, the facility manager wonders what the additional costs are in terms of risk and time. What labor hours are needed to support energy efficiency efforts? Should they allocate labor hours to making dollars, or saving dimes?[94]

Company employees may also be reluctant to admit the need to invest in cleaner energy technologies, Russell notes, "because they believe such admissions become evidence of ineffective job performance.[95]"

Ultimately, energy use continues to be invisible to most companies. "[N]o single business 'can improve [its] bottom line substantially with alternative energy technologies, because energy inputs usually constitute less than 1 percent of their total cost structure.'"[96] Companies will often choose to pursue more profitable ventures instead of investing in energy technologies. A study of industrial energy usage undertaken by the ASE found that compressed air leaks were often overlooked because air was believed to be free, even though the same companies needed five horsepower of electricity to generate one horsepower of compressed air.[97] Similarly, the study found that plant operators may assume that scrap rates are unimportant because scrap can be melted down and reused, not realizing that recycling scrap

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[94] *Id.* at 84 (quoting Interview with Chris Russell, Director, Alliance to Save Energy (Feb. 8, 2005)).

[95] *Id.* (citing Christopher Russell, *Barriers to Industrial Energy Cost Control: The Competitor Within*, INSULATION OUTLOOK, Aug. 2005, at 1–2, *available at* http://www.insulation.org/articles/article.cfm?ID=IO050806).

[96] *Id.* at 84–85 (quoting interview with Shalom Flank, Chief Technical Officer, Pareto Energy Limited (Mar. 20, 2006)).

[97] Christopher Russell, *Barriers to Industrial Energy Cost Control: The Competitor Within*, INSULATION OUTLOOK, Aug. 2005, at 1–2, *available at* http://www.insulation.org/articles/article.cfm?ID=IO050806.

requires energy consumption and associated costs.[98]

Ironically, in the case of energy efficiency practices and combined heat and power systems, the smaller the project, the *less* likely it will be undertaken. As the vice president at one engineering firm put it,

> "size matters—not necessarily from a capital cost or efficiency standpoint, but it takes a lot of effort to do a small project as it does a large project, so the tendency is for an organization like ours to focus on the bigger projects because they can support the kinds of efforts needed to get the projects done. In contrast, getting smaller projects done requires such a disproportionate amount of senior management attention, legal attention, and other time and effort that it really burdens those projects with greater and greater costs so that people say it's not worth it."[99]

In the solar (photovoltaic) market, it is difficult to even get an otherwise fragmented energy industry to work together. Even though large firms such as General Electric and British Petroleum are interested in the market, solar energy is not their main line of business.[100] "A plethora of small manufacturers commit their limited R&D resources to address major innovations, but improvement continues to be 'incremental' and 'sluggish,'" especially since such firms do not have the resources to fully learn what other manufacturers are doing.[101]

Analogously, most firms researching carbon capture and storage remain unaware of IP relating to other, alternative mechanisms for low-cost carbon sequestration. "The companies working on developing the latest amine combination for carbon capture are disconnected from those designing cutting-edge gasifiers, making it all but impossible to benchmark innovations and determine how individual technologies are maturing."[102]

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[98] *Id.*

[99] Sovacool, *supra* note 93, at 237 (quoting Interview with Mark Hall, Senior Vice President, Primary Energy (Oct. 5, 2005)).

[100] *See* General Electric Businesses, http://www.ge.com/company/businesses/index.html (last visited Mar. 9, 2008) (illustrating that renewable energy systems are only a small portion of the General Electric corporate businesses); British Petroleum Overview, http://www.bp.com/subsection.do?categoryId=5&contentId=2006530 (last visited Mar. 9, 2008) (illustrating British Petroleum's various business interests).

[101] CARBON LOCK-IN, *supra* note 71, at 93 (quoting Telephone Interview with Ajeet Rohatgi, Director, University Center of Excellence for Photovoltaic Research and Education, Georgia Institute of Technology (Nov. 20, 2006)).

[102] *Id.* at 80–81 (Telephone Interview with Susan Hovorka, Carbon Capture and Storage Expert, Bureau of Economic Geology, University of Texas (Nov. 14, 2006)).

For wind technologies, a pressing problem has emerged related to wind rights contracts for small landowners. Wind rights are generally recognized under two common law doctrines: the united fee ownership rule (the idea that a landowner's property rights extend to everything from the center of the earth to the sky, such as rainfall from clouds over their property) dictates a legal right to harvest the wind that blows across their land, and traditional mineral rights doctrine (which establishes that surface rights may remain in the possession of one person or entity, while the right to extract various minerals lies with another) suggests that wind, like oil and natural gas, is a resource that can be sold.[103]

Significant transaction costs accrue to the landowner, however, since wind developers take part in a number of wind rights deals, but individuals only once.[104] Wind developers may have been able to exploit such transaction costs by creating contracts that improperly assess site valuation (windiness, proximity to electric power lines, cost of building access roads), inspection and performance measurements, the right to an independent audit of the developer's books, property taxes, tort liability for damages, and plans for decommissioning and land reclamation once the wind contract expires.[105] Since wind rights contracts typically span thirty years or more, poorly designed or abusive contracts can have lasting consequences for the land owner, as well as their children and subsequent purchasers of their land, and create significant disincentives for investing in wind technology.[106]

Furthermore, the transaction costs associated with policing and enforcement of patents deter some firms from innovating. "[W]hen research is sequential and builds upon previous discoveries, stronger patents may discourage subsequent research on valuable, but potentially infringing, follow-on inventions."[107] Conducting a patent infringement case may, for

[103] Joseph O. Wilson, Note, *The Answer, My Friends, Is In the Wind Rights Contract Act: Proposed Legislation Governing Wind Rights Contracts*, 89 IOWA L. REV. 1775, 1784 (2004).

[104] *Id.* at 1776–77.

[105] *See id.* at 1786–95 (discussing the role of the Wind Rights Contract Act in protecting landowners from lack of information about these factors).

[106] *Id.* at 1777.

[107] Gallini, s*upra* note 87, at 132 (citing Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990); Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29 (1991)).

instance, cost between one and several million dollars.[108] "[T]he costs of patent litigation" in the early 1990s accounted for more than $1 billion, or more than "[twenty-seven] percent of expenditures on basic research by U.S. firms in that year."[109] When firms lose an infringement case, they can be forced to pay millions of dollars in damages or—worse—face court ordered injunctions to suspend operation.[110]

"[A] survey of 600 [small to medium enterprises] . . . found that [f]or [forty-nine percent] of the firms, fear of cost of patent defense litigation had a 'very big' or 'significant' impact on their investment in invention."[111] Smaller firms also felt more intimated by the prospect of patent litigation than did larger ones; fifty-five percent of small biotechnology firms and thirty-three percent of large ones reported that patent litigation to be "a deterrent to innovation," that smaller firms were even more damaged by costly preliminary injunctions, and that firms requesting injunction tended to be twice as large as those that did not.[112] Many firms concerned with the high costs of litigation appear to avoid research areas that are occupied by other firms all together.[113] "[S]trong broad patent rights entail major economic costs while generating insufficient additional social benefits," since "across-the-board strengthening of [patents] courts the danger of increasing litigational conflicts and costs in . . . 'cumulative systems technologies.'"[114] Increased competition further amplifies the risk that small firms will not seek certain innovations, as they may lack the needed funds and equipment for risky projects.

B. Cognitive Bias among Researchers, Managers, and

[108] *Id.* at 148 (citing Robert P. Merges, *As Many as Six Impossible Patents before Breakfast: Property Rights for Business Concepts and Patent System Reform* (Univ. of Cal. at Berkeley, Working Paper, 1999)).

[109] *Id.* at 148 (citing Joshua Lerner, *Patenting in the Shadow of Competitors*, 38 J.L. & ECON. 463 (1995)).

[110] *See* Joshua Lerner, *Patenting in the Shadow of Competitors*, 38 J. L. & ECON. 463, 468, 479 (1995).

[111] Petr Hanel, *Intellectual Property Rights Business Management Practices: A Survey of the Literature*, 26 TECHNOVATION 895, 915 (2006) (discussing the reaction of small to medium enterprises from the EU that "obtained a European or US patent between 1994 and 1997").

[112] Gallini, s*upra* note 87, at 149 (citing Jean O. Lanjouw & Joshua Lerner, *Tilting the Table? The Use of Preliminary Injunctions*, 44 J.L. & ECON. 573, 575 (2001); Lerner, *supra* note 110, at 463.

[113] *Id.* (citing Lerner, *supra* note 110, at 489–90).

[114] Mazzoleni & Nelson, *supra* note 40, at 281.

Policymakers

As a second IPR impediment, researchers, managers, and policymakers frequently think in deterministic rather than probabilistic terms about research.[115] This condition is further complicated by an attribution bias that people overestimate their own assets and disparage the claims of their opponents.[116] Such cognitive and attribution biases influence multiple dimensions of the technological development process, from how researchers perceive the profitability of applying for a patent to the ease with which the technology could be reverse engineered and the needed breadth of patent protection.[117] "People consistently overestimate the likelihood that very low probability events of high salience will occur."[118] The classic example is travelers overestimating the danger of an airplane crash relative to other modes of transportation.[119] In a similar way, most inventors may hold an inherent bias towards their own patent, and have difficulty assigning value to the work of others.[120]

"[D]isparate expectations about the value of [an] invention may prevent the inventor and prospective licensees from settling on an acceptable royalty."[121] An analysis of 96,713 patents issued by the USPTO in 1991 found that a high rate of patents expired, suggesting that patentees rush to patent before ascertaining meaningful estimates of expected return on a given technology.[122] Strong patenting can lead to "socially inefficient monopoly pricing," since "firms in a patent race may overinvest in research if the patent is worth more than the (minimum) cost of achieving [protection]."[123] Moreover, "[a]n increase in one firm's rate of

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115 *See* Heller & Eisenberg, *supra* note 86, at 698 (analogizing patent holders who overvalue their patents to passengers who overvalue the probability of an airplane crash over other types of transportation accidents).

116 *Id.* (citing Lee Ross & Craig A. Anderson, *Shortcomings in the Attributions Process: On the Origins and Maintenance of Erroneous Social Assessments*, *in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 129 (Daniel Kahneman et al. eds., 1982)).

117 *See id.*

118 *Id.* at 701 (citing Amos Tversky & Daniel Kahneman, *Advances in Prospect Theory: Cumulative Representation of Uncertainty*, 5 J. RISK & UNCERTAINTY 297 (1992)).

119 *Id.*

120 *Id.* at 700.

121 Gallini, s*upra* note 87, at 137.

122 *See* Kimberly A. Moore, *Worthless Patents*, 20 BERKELEY TECH. L.J. 1521, 1530, 1540 (2005) (noting that 53.71% of the patents studied "expired before their full term").

123 Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative*

investment transfers some probability of becoming the patentholder from other firms to itself," meaning that "all firms might [similarly] overinvest."[124] The heterogeneous interests of patent owners can complicate negotiations. Conflicting agendas may make it difficult for firms to reach agreement; private firms often want to use IPR to maintain lucrative product monopolies and patent owners differ in the time frames they can tolerate for recouping investments.[125]

Sometimes attribution biases swing the other way. Two firms may each view the other as likely to win a patent race, so that neither pursues research. Thus, strong IPR can reduce competition in areas where large facilities are needed for experimentation and testing, excessively adding to the costs of duplicating experiments.[126] Put another way, forcing projects from separate companies runs the risk that companies will undertake parallel R&D practices that must be discontinued as soon as an idea is patented. "Because innovators do not have full access to information, companies and firms may overestimate the danger that their new products will inadvertently infringe on patents issued after these products were designed."[127] Collectively, cognitive biases may impede innovation by distorting the patent filing process, investment decisions, and the strength of competitors' positions.

IPR transaction costs, such as acquiring information about existing patents, filing with the USPTO, and enforcing patents, may not be that large. However, taken collectively, they become almost "insurmountable" for inventors.[128] The costs of moving new technologies from the cradle to the marketplace add up quickly and multiply, so that many people refuse to even start the process of invention. Many researchers have excellent ideas for new technologies that would drastically improve the energy efficiency and security of the country, but cannot get past the IPR

Research and the Patent Law, 5 J. ECON. PERSP. 29, 31 (1991) (citing Glenn C. Loury, *Market Structure and Innovation*, 93 Q. J. ECON. 395 (1979)).

[124] *Id.*

[125] Heller & Eisenberg, *supra* note 86, at 670.

[126] Linda R. Cohen & Roger G. Noll, *The Future of the National Laboratories*, 93 PROC. NAT'L ACAD. SCI. 12,678, 12,685 (1996).

[127] CARBON LOCK-IN, *supra* note 71, at 72–73 (citing Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION AND THE ECONOMY 119, 119, 120 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., 2000)).

[128] Telephone Interview with Toni Marechaux, Consultant, Strategic Analysis, Inc. (Nov. 28, 2006).

starting mark. And when these individuals do try to innovate, they spend most of their time negotiating licenses and royalties, finding investors, buying other patents, protecting their ideas from infringement, collecting information and complaining about it, so that almost no time is left for what counts—the technology itself. The patent system itself may act as a hurdle, especially when inventors can simply leave the U.S. to innovate somewhere else.[129]

C. Low Returns on Energy IPR Investments

Historically insufficient spending on energy R&D in the public and private sectors acts as a third IPR barrier. In "the energy sector as a whole, the total number of energy technology related patents has exhibited a strong correlation with total energy R&D investments."[130]

Yet investment in energy R&D has declined significantly since the 1980s.[131] During the 1990s, the federal government invested approximately three percent of its total R&D expenditures on energy, even though energy industries contribute more than eight percent to the country's GDP.[132] Federal funding for R&D, in efficiency measures, distributed generation, and renewable energy technologies, for instance, has declined as a portion of real GDP by more than seventy percent over the past ten years.[133] After funding for such technologies peaked in 1980 at $1.3 billion, it declined to $560 million in 1981 and just under $140 million in 1990 (in 2002 dollars).[134]

Recent events in the energy sector make it unlikely that

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[129] *Id.*

[130] Robert M. Margolis & Daniel Kammen, *Evidence of Under-Investment in Energy R&D in the United States and the Impact of Federal Policy*, 27 ENERGY POL'Y 575, 576 (1999).

[131] Robert N. Schock et al., *How Much is Energy Research & Development Worth as Insurance?*, 24 ANN. REV. ENERGY & ENV'T 487, 488 (1999).

[132] *See id.* (noting that from 1985 to 1994, the U.S. annual investment in energy R&D decreased by approximately two billion dollars) (citing TASK FORCE ON STRATEGIC ENERGY RES. AND DEV., DEPT. OF ENERGY, ENERGY R&D: SHAPING OUR NATION'S FUTURE IN A COMPETITIVE WORLD (1995); JJ DOOLEY, REP. NO. PNNL-11295 UC400, TRENDS IN US PRIVATE-SECTOR ENERGY R AND D FUNDING 1985–1994 (1996)).

[133] Woodrow Clark & William Isherwood, *Distributed Generation: Remote Power Systems with Advanced Storage Technologies*, 32 ENERGY POL'Y 1573, 1577 (2004).

[134] INT'L ENERGY AGENCY, RENEWABLE ENERGY: MARKET & POLICY TRENDS IN IEA COUNTRIES 646 fig.5, 647 (2004).

private industry will compensate for public underinvestment. Restructuring of the electric utility industry and the repeal of the Public Utilities Holding Company Act of 1935 (PUHCA) may have only increased the incentive for companies and firms to invest in short-term technologies with rapid financial returns.[135] Utilities are more likely to make investments only in short term products that have better discount rates, lower risk, and perceived better quarterly returns for investors.[136] As a result, R&D *intensity*—expenditures for R&D as a percentage of a company's total sales for one year—among energy firms averages .03 percent, compared to an average industrial benchmark of 3.1 percent.[137]

Consequently, the prevalence of federal R&D funds in other, non-energy sectors, coupled with the relatively low cost of energy discourages universities from patenting greenhouse gas reducing technologies and projects. John McTague, former vice president of research at Ford Motor Company, suggests that industry is not as interested in federal R&D "because the federal government is no longer conducting as much research."[138] McTague told *Manufacturing and Technology News* that "[i]f the federal efforts are fractionally lower, if an industrial corporation is looking for partners, it sees more partners among its peers now than it does in the federal government."[139]

D. Structural Problems within the Government Licensing and Reporting Process

Two sets of barriers relate to structural problems within the

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[135] *See* Benjamin K. Sovacool, *PUHCA Repeal: Higher Prices, Less R&D, and More Market Abuses?*, 19 ELECTRICITY J. 85, 85, 87 (2006).

[136] *See id.* at 87 (arguing that PUHCA's repeal could bring about less investment in new technologies and more investment in existing facilities); Steven Nadel & Marty Kushler, *Public Benefits Funds: A Key Strategy for Advancing Energy Efficiency*, 13 ELECTRICITY J. 74, 82 (2000) (stating that the restructuring of the electric industry has decreased investment in new, energy efficient technologies).

[137] J.J. Dooley, *Unintended Consequences: Energy R&D in a Deregulated Energy Market*, 26 ENERGY POL'Y 547, 551 (1998) (citing NAT'L SCI. BD. NAT'L SCI. FOUND., SCIENCE AND ENGINEERING INDICATORS (1996); GEN. ACCOUNTING OFFICE, GOA-RCED-96-203, CHANGES IN ELECTRICITY-RELATED R&D FUNDING 6 (1996)).

[138] *Technology Transfer: Frustrated Industry Shuns Government Laboratory Research*, MANUFACTURING AND TECH. NEWS, Sept. 16, 2002, *available at* http://www.manufacturingnews.com/news/02/0916/art1.html.

[139] *Id.*

USPTO and federal patents. In order for an invention or technology to be patented, it must meet four requirements: utility, novelty, disclosure, and non-obviousness.[140] However, patent professionals are "drowning" in a "flood of patent information."[141] "For years the USPTO has been struggling to get out from under a backlog of increased case loads. Nearly one-third of the 355,000 new patent applications received in fiscal 2004 involved resubmissions of previous applications."[142] The Committee on Intellectual Property Rights at the National Academy of Sciences noted that the sheer volume of patent applications is overwhelming the patent corps, degrading the quality of their work, and creating a huge backlog of pending applications.[143]

"[T]he number of [patent] examiners has not kept pace with increase in [workload]";[144] "patent offices working under time constraints, cannot perform fully comprehensive searches to reveal the true state of the art."[145] "[T]he number of patent applications processed [has] more than doubled since 1995," while "the number of hours spent examining each patent has [dropped] . . . from 23.8 h[ours] in 1992 to 11.8 h[ours] in 2001."[146] The trend has also been towards more complex applications and longer pages of description, resulting in an increase in both the "scope and the length of applications."[147] "[A] survey of 1300 patent examiners" at the European Patent Office noted that a majority felt that "they [did] not have enough time for patent examination . . . Two-thirds agreed that they lacked the time to do back-up examinations."[148] A separate report from the Federal Trade Commission noted that participants in their study "unanimously held the view that the

[140] 35 U.S.C. §§ 101, 103, 112 (2008)).

[141] Minoo Philipp, *Patent Filing and Searching: Is Deflation in Quality the Inevitable Consequence of Hyperinflation in Quantity?*, 28 WORLD PAT. INFO. 117, 118 (2006).

[142] Ted Agres, *USPTO Proposes Controversial Patent Filing Changes*, 20 THE SCIENTIST 80 (2006).

[143] *See* NAT'L RESEARCH COUNCIL, A PATENT SYSTEM FOR THE 21ST CENTURY 103–05 (Stephen A. Merrill, Richard C. Levin & Mark B. Myers eds., 2004).

[144] *Id.* at 104.

[145] Philipp, *supra* note 141, at 118.

[146] *Id.* at 119–20 (citing Alison Abbott, *Pressured Staff 'Lose Faith' in Patent Quality*, 429 NATURE 493 (2004)).

[147] *Id.* at 120.

[148] *Id.* at 119.

PTO [did] not receive sufficient funding for its responsibilities."[149]

Such a high level of patent complexity—combined with a lack of focused experience among some PTO staff members—frequently results in improper rejection of patents due to the mistaken idea that the idea is not new, as well as overly broad patents that give owners excessive control over a particular area. For example, one sulfur hexafluoride alternative, fluoro-ketone, is being patented by 3M and grants the company legal rights to future emission reduction credits.[150] This provides an element of uncertainty for magnesium companies—they do not know how much of their potential future revenue from emission reduction credits they would be displacing were they to use fluoro-ketone.[151]

The USPTO appears to be allowing more vague patents that do not appear offhand to meet the standards of novelty and non-obviousness.[152] This creates a real danger that a single new product or service infringes on multiple patents, and many patents cover products already being used when the patent is issued, making it harder for companies building businesses to invent around such patents.[153] The ability for a patent holder to seek injunctive relief—or threaten to suspend operations of the infringing company—exacerbates the risks involved with patenting.[154] "[P]atent examiner training and the resources available to patent examiners have not kept pace with the change in the way technology works and the way the patent system works and is now used by inventors."[155]

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[149] FTC, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 10 (2003), *available at* http://www.ftc.gov/os/2003/10/innovationrptsummary.pdf.

[150] Telephone Interview with Sally Rand, Non-CO2 Programs Branch, Climate Change Div., EPA (Nov. 20, 2006).

[151] *Id.*

[152] *See* Doug Harvey, Comment, *Reinventing the U.S. Patent System: A Discussion of Patent Reform through an Analysis of the Proposed Patent Reform Act of 2005*, 38 TEX. TECH L. REV. 1133, 1170 (2006).

[153] *Navigating the Patent Thicket*, *supra* note 78, at 121.

[154] *Id.*

[155] Robert A. Armitage, *The Conundrum Confronting Congress: The Patent System Must be Left Untouched While Being Radically Reformed*, 5 J. MARSHALL REV. INTELL. PROP. L. 268, 274 (2006) (citing *Improvements Needed to Better Manage Patent Office Automation and Address Workforce Challenges*: *Testimony Before the Subcomm. on Courts, the Internet, and Intellectual Property of the H. Comm. on the Judiciary*, 109th Cong. 1 (Sept. 8, 2005) (statement of Anu Mittal, Director, Science and Technology Issues & Linda D. Koontz, Director, Information Management Issues), *available at*

Indeed, the problem may be underestimated, since "many patents that issue today are effectively unenforceable because the cost of enforcement exceeds [the] economic value [of the patent]."[156] The increase in the number of doubtful applications being granted inflates the number of patents being issued and deflates their quality. This creates a vicious cycle at the USPTO: the lower quality of issued patents increases the number of abuses and lawsuits within the system, causing more work at the USPTO, and thus, a greater risk of lower quality patents.[157]

Such problems at the USPTO threaten to create at least three unintended consequences. First, it engenders considerable litigation costs for those wishing to oppose or nullify unduly granted patents. This harms competition by forcing participants to pay royalties, incur substantial legal expense to defend against infringement claims, or engage in design efforts that do not compromise the doctrine of equivalents, or hindering product performance. Second, holders of dubious patents are unjustly enriched in the absence of litigation, and the entry of competitive products and services is often deterred or delayed within a given market. Third, low quality patents negatively affect patent owners and investors, who may make far-reaching decisions to build facilities based on unrealistic expectations. Individually or collectively, each of these consequences produce "anticompetitive effects [that] can cause unwarranted market power and can unjustifiably increase [transaction] costs."[158]

A second set of barriers concerns the federal recording of patents under the Bayh-Dole Act. The Bayh-Dole Act requires contractors, grantees, and the recipients of CRADAs to follow specific reporting requirements regarding disclosure, election to retain title, application for patent, licensing, and commercialization of any invention subject to the act.[159] However, numerous federal agencies and their contractors and grantees—including those at the U.S. Department of Energy—are not complying. Databases for recording the government's interests in the inventions were inaccurate, incomplete, and

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http://www.gao.gov/new.items/d051008t.pdf).

[156] *Id.* at 277.

[157] Harvey, *supra* note 152, at 1170 (citing NAT'L RES. COUNCIL, A PATENT SYSTEM FOR THE 21[ST] CENTURY 54, 59, 76 (Stephen A. Merrill, Richard C. Levin & Mark B. Myers eds., 2004)).

[158] FTC, *supra* note 149, at 5.

[159] Bayh-Dole Patent and Trademark Laws Amendment Act, Pub. L. No. 96-517, 94 Stat. 3015 (1980).

inconsistent, meaning that the government is often unaware of inventions to which it has royalty-free rights, further hindering innovation.[160]

III. ANTI-COMPETITIVE PATENT TECHNIQUES AND PRACTICES

Apart from some of the structural and economic problems inherent with IPR, many firms intentionally use patents as tools to impede innovation and competition. Three of the more severe anti-competitive practices—submarine patents, patent suppression, and patent blocking—will be explored in detail.

A. Submarine Patents

Some companies will collect patents on products that they never intend to manufacture or produce. This technique, called warehousing, occurs when companies "warehouse patent rights in order to extract cash from entities that are found to be infringing these rights."[161] "[T]hese companies do not actually make or sell anything," but simply own the patent so that they can acquire damages once the patent is infringed.[162]

One of the more pervasive methods of warehousing concerns the use of submarine patents. A submarine patent occurs when an inventor or firm files an application with broad or incomplete claims, and then files continuing applications to keep the patent submerged in the patent office.[163] Once someone else innocently decides to use the patented idea, "the inventor surfaces the application through its issuance, and demands the payment of royalties."[164] The technique, also called "trolling," is an ingenious, if not predatory abuse of the patent continuation

[160] *See* U.S. GEN. ACCOUNTING OFFICE, GAO-03-47, INTELLECTUAL PROPERTY FEDERAL AGENCY EFFORTS IN TRANSFERRING AND REPORTING NEW TECHNOLOGY 26–27 (2002), *available at* http://www.gao.gov/new.items/d0347.pdf (reporting the lack of license information on government owned technology in data reported by federal agencies).

[161] Ted Sabety, *Nanotechnology Innovation and the Patent Thicket: Which IP Policies Promote Growth?* 15 ALB. L.J. SCI. & TECH. 477, 509 (2005); *see also* Uche Ewelukwa, *Patent Wars in the Valley of the Shadow of Death: The Pharmaceutical Industry, Ethics, and Global Trade*, 59 U. MIAMI L. REV. 203, 250 (2005) (discussing manufacturers' warehousing of patents).

[162] Sabety, *supra* note 161, at 509.

[163] Steve Blount, *The Use of Delaying Tactics to Obtain Submarine Patents and Amend Around a Patent that a Competitor Has Designed Around*, 81 J. PAT. & TRADEMARK OFF. SOC'Y 11, 13 (1999).

[164] *Id.* at 13.

process.[165] Inventors can file continuations and make adjustments to include any subsequent inventions made by others to keep their patents "submerged" at the USPTO for years.[166] Submarine patents involve using the patent as a form of speculation: if an invention becomes commercially successful, its owner can sue the developer and recover damages for infringement.[167] Since complex technological projects often involve multiple, overlapping inventions, firms will intentionally patent parts of the production process—not to make products or diffuse technology—but to lurk until a rival company invents around the area of the patent.[168]

Submarine patents impede innovation in at least two ways. First, they can create a virtual monopoly on a given process or product and, thus, elicit monopoly behavior and rising costs. Second, such patents, if they cannot be invented around, act merely as a tax on innovation, and in a large project "the cumulative effect of many small 'taxes' can become quite large."[169] The problem can be further magnified in a complicated industry where hundreds ,if not thousands of patents, issued or pending, can relate to a given product, creating a veritable "mine field" for inventors.[170]

The idea of "submarining" or "trolling" patents is not new, and dates back to the 1890s, when George B. Selden, a patent attorney, kept a patent on the first automobile pending for 16 years.[171] He sold his rights in 1898 for $10,000 to Colonel Albert Pope, who then pressured the first automobile manufacturers to pay him 1.25 percent of every car sold. A more infamous example

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[165] *See* Todd Klein, Ebay v. Mercexchange *and* KSR Int'l Co. v. Teleflex, Inc.*: The Supreme Court Wages War Against Patent Trolls*, 112 PENN ST. L. REV. 295, 295–96 (2007) (citing David G. Barker, *Troll or no Troll? Policing Patent Usage with an Open Post-Grant Review*, 9 DUKE L. & TECH. REV. 9, P7 (2005) (identifying "[p]atent trolls" as "individuals or companies that purchase patents and assert them with no intention of creating or manufacturing a product using the patented technology")).

[166] *See* Blount**,** *supra* note 163, at 13.

[167] Harvey, *supra* note 152, at 1162 (citing WENDY H. SCHACHT & JOHN R. THOMAS, C.R.S. REPORT FOR CONGRESS, PATENT REFORM: INNOVATION ISSUES 15 (2005), *available at* http://patentlaw.typepad.com/patent/RL32996.pdf).

[168] *See Navigating the Patent Thicket*, *supra* note 78, at 121.

[169] *Id.* at 125.

[170] *Id.* at 126.

[171] Blount, *supra* note 163, at 13–14 (citing Charles Hillinger, *Auto History Parked Safely in Detroit*, L.A. TIMES, Mar. 19, 1989, § 6, at 10; Roger Rowand, *Ford Freed the Slaves in Selden Patent Lawsuit*, AUTOMOTIVE NEWS, June 26, 1996, at 44).

relates to the late Jerome Lemelson, who used the submarine method to extract billions of dollars in patent infringement cases related to important components of videocassette recorders, automated teller machines, cordless phones, fax machines, compact disc players, welding robots, machine vision, and image processing.[172]

"[A]n epidemic of submarine patents" occurred in the 1980s and early 1990s.[173] One study "identified 320 cases of patents that were granted between 1971 and 1996 that . . . [were] pending in the PTO . . . for at least fifteen years, were under secrecy order, and were refiled at least twice."[174] "A substantial number of those applications were pending in the [PTO] more than twenty years," with some pending "for more than forty years."[175] To address these concerns, U.S. patent law was modified in 1995 to "change[] the patent term from seventeen years from the date of grant to twenty years from the date of filing."[176]

Submarine patents, however, are not dead. A number of practitioners still engage in the practice of continuing applications and amending them in response to efforts from a competitor to design around the patent.[177] An opportunity for gaming lingers since the current law allows those filing patents to keep "the scope of claims confidential for ten years and then spring[] it on the U.S. industry."[178] Since modern technology improves so quickly, delays of even a couple of years can have a prophylactic effect on innovation.[179]

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[172] *Id.* at 19; Robert Greene Sterne, Michael Q. Lee, Patrick E. Garrett, Michael V. Messinger & Donald R. Banowit, *The 2005 U.S. Patent Landscape for Electronic Companies*, PRACTISING L. INST., Mar. 2005, at 293, 309–10 (citing Nicholas Varchaver, *The Patent King*, FORTUNE, May 14, 2001, *available at* http://money.cnn.com/magazines/fortune/fortune_archive/2001/05/14/302986/index.htm).

[173] Symposium, *Early Patent Publication: A Boon or Bane?: A Discussion on the Legal and Economic Effects of Publishing Patent Applications After Eighteen Months of Filing*, 16 CARDOZO ARTS & ENT. L.J. 601, 620 (1998) [hereinafter Symposium].

[174] *Id.*

[175] *Id.* at 621.

[176] *Id.* (referring to 35 U.S.C. § 154(a)(2) (1994)).

[177] *See* Blount, *supra* note 163, at 12 (suggesting that there will be an increased in the use of "submarine patents" in the future).

[178] Symposium, *supra* note 173, at 621.

[179] Christopher C. Smith, Comment, *The Submarine Defense System Misfires: Patent Prosecution Laches After Symbol Technologies*, 40 GONZ. L. REV. 235, 241 (2005).

B. Patent Suppression

A second anti-competitive patent technique concerns suppression. Generally, patents must balance two competing goals: giving adequate economic incentives to pioneering inventors, and ensuring that the innovations are followed and the public is benefited.[180] Companies, however, have an incentive to suppress new and innovative technology if it threatens to disrupt profits in a market.

Patent suppression refers to "any type of conduct or agreement that limits the availability, use, or development of a particular process or product, or that limits or chills the ability of others to create or exploit such an innovative process or product."[181] It "involves the unilateral non-use of technology—that is, a single firm deciding independently . . . not to use or license . . . its own intellectual property."[182] Suppression "is a historical and contemporary reality that extends beyond obscure inventions to well-known and widely-used products," and it has been estimated that between "forty to ninety percent of issued patents are not used or licensed by the patentee."[183] Patent suppression is particularly challenging to research and document because "the courts have been reluctant to view this conduct as unlawful," and most of the information never diffuses into public record.[184] As Charles Allen Black argues, "[e]conomic markets will always encourage and reward technology suppression (whether patented or not) if the technology could displace established markets or reduce profit margins."[185] Suppression is not always intentional, nonetheless, and can occur due to "inadequate finances, incompetence of patent owners, delay in development of

180 *Id.* at 236 (citing Pfaff v. Wells Elecs., Inc., 525 U.S. 55, 64–65 (1998)).

181 Saami Zain, *Suppression of Innovation or Collaborative Efficiencies?: An Antitrust Analysis of a Research & Development Collaboration that Led to the Shelving of a Promising Drug*, 5 J. MARSHALL REV. INTELL. PROP. L. 348, 348 (2006) (quoting Joel M. Cohen & Arthur J. Burke, *An Overview of the Antitrust Analysis of Suppression of Technology*, 66 ANTITRUST L.J. 421, 426 (1998)).

182 Joel M. Cohen & Arthur J. Burke, *An Overview of the Antitrust Analysis of Suppression of Technology*, 66 ANTITRUST L. J. 421, 422 (1998).

183 Kurt M. Saunders, *Patent Nonuse and the Role of Public Interest as a Deterrent to Technology Suppression*, 15 HARV. J.L. & TECH. 389, 391–92 (2002).

184 Kurt M. Saunders & Linda Levine, *Better, Faster, Cheaper-Later: What Happens When Technologies Are Suppressed*, 11 MICH. TELECOMM. & TECH. L. REV. 23, 25 (2004).

185 Charles Allen Black, *The Cure for Deadly Patent Practices: Preventing Technology Suppression and Patent Shelving in the Life Sciences*, 14 ALB. L.J. SCI. & TECH. 397, 401 (2004).

inventions, sunk costs, [and disparity in] product and geographic markets."[186]

While patent suppression has been used by caviar companies to suppress artificial caviar, by Xerox to protect plain paper photocopier technology, by the Automobile Manufacturers Association for suppressing air pollution control equipment, and by tobacco companies to suppress safer and less addictive cigarettes, perhaps two of the most famous examples concern early energy technologies.[187]

Suppression involving patent[s] . . . can also be found in the history of the electric lamp industry[,] . . . born after Thomas Edison patented the first incandescent electric lamp in 1880. Competing in the industry required a large investment of fixed capital and specialized plants with high overhead costs. These investments, coupled with an inelastic demand for electric lamps, made competition difficult and cartelization more likely. General Electric emerged as the leader in the U.S. lamp industry."[188]

GE did so by "enter[ing] into several cross-licensing agreements with competitors to divide domestic markets, to fix prices, and to regulate exports."[189] As a result, incandescent light bulbs with long life spans were intentionally suppressed.

A similar pattern of collusive activity occurred with the development of fluorescent light bulbs. By the 1920s, the basic technology for fluorescent lighting was patented and widely-known. Yet, General Electric and Westinghouse, the leading U.S. manufacturers, were determined to saturate the incandescent light market before releasing the new technology. This delay was made possible in part by a licensing agreement between the two manufacturers that explicitly forbade Westinghouse from underpricing General Electric in exchange for allowing Westinghouse to use General Electric's tungsten filament patents. In addition, the licensing agreement controlled Westinghouse's output so that it was always limited to a specific percentage of the combined net sales of patented incandescent light bulbs made by both firms.

The suppression of fluorescent lighting was partially in

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[186] Saunders & Levine, *supra* note 184, at 27.

[187] *Id.* at 29–35; Saunders, *supra* note 183, at 392–93.

[188] Saunders, *supra* note 183, at 407 (citing GEORGE W. STOCKING & MYRON W. WATKINS, CARTELS IN ACTION: CASE STUDIES IN INTERNATIONAL BUSINESS DIPLOMACY 307–12 (Kraus Reprint Co. 1975) (1946)).

[189] *Id.* (citing STOCKING & WATKINS, *supra* note 188, at 308).

response to pressure from electric utility companies, which believed that the increased efficiency of fluorescent lighting would lead to reduced demand for electricity and lowered profits. The lighting and electric industries were highly dependent on each other.[190] Further, utilities believed that the fluorescent lamp would negatively affect electricity load.[191] They especially viewed more efficient lighting as a serious impediment towards electrifying rural areas since large increases in demand were the primary justification for the expansion of electricity grids.[192] Fluorescent light bulbs were suppressed until 1938, when Sylvania, a new competitor, successfully threatened to become the industry leader in the production of efficient bulbs.[193]

Suppression has been documented in a variety of other energy technologies, such as alternative fuel vehicles and photovoltaic (solar) panels.[194] In the 1970s, for instance, Paul Pantone invented a carburetor that "incorporate[ed] an internal refinery, us[ing] a process called thermal resonant cracking."[195] Such an engine could run on unrefined fuels and yielded much less pollution than conventional combustion engines, but was never pursued by the automobile companies that shared its patent.[196] In addition, Tom Ogle developed an automotive system for Ford Motor Company that "used a series of hoses that fed a mixture of gas vapors and air directly into the engine."[197] A small number of prototypes were built that averaged 100 mpg at 55 mph, but—again—the technology was ultimately suppressed.[198]

C. Blocking and Cross-Licensing

As a final anti-competitive practice, some firms will patent processes and technologies only to block other firms from

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[190] Saunders, *supra* note 183, at 409.
[191] *Id.* at 408.
[192] *See id.* at 408–09.
[193] Saunders, *supra* note 183, at 409 (citing ARTHUR A. BRIGHT, JR., THE ELECTRIC-LAMP INDUSTRY: TECHNOLOGICAL CHANGE AND ECONOMIC DEVELOPMENT FROM 1800 TO 1947 400–01 (1949)).
[194] Saunders & Levine, *supra* note 184, at 33–35.
[195] *Id.* at 34 (citing Paul Pantone and Other Links, http://www.linux-host.org/energy/eppantone.html (last visited Oct. 2, 2008)).
[196] *Id.*
[197] *Id.*
[198] *Id.* (citing Gregory Jones, *The Tom Ogle Story*, http://www.linux-host.org/energy/etomogle.html (last visited Oct. 2, 2008); John Doussard, *200 Miles on Two Gallons of Gas*, EL PASO TIMES (May 1, 1977); *In re* Multidistrict Vehicle Air Pollution, 367 F. Supp. 1298 (C.D. Cal 1973)).

entering the market. "[T]he 'static' costs associated with a patent-protected monopoly position . . . deters other firms from trying themselves to invent 'in the neighborhood'" of other patents.[199] Thus, firms are deterred from undertaking a variety of follow up work that improves an initial invention.

Patents can more directly block innovation when "firms try to patent the entire production process by applying for as many patents as possible for one product. Competitors have to approach the respective firm and apply for licenses whenever they want to produce something in the area."[200] Large pharmaceutical companies often adhere to this practice to block entry into the market.[201] Firms can then respond with only three options: (a) "trying to invalidate [the] patents," (b) trying to "invent around them", or (c) "simply ignor[ing] them and risk[ing] an infringement suit."[202] A survey of European companies found that more listed "[i]mped[e] competitors' patenting and application activities" as an incentive to patent, instead of "[a]cquisition of venture capital."[203]

Similarly, a survey of 1,478 R&D laboratories in the U.S. found that a majority of firms are starting to rely on patent blocking, especially when numerous, separately patentable inventions need to be combined to produce a single product.[204] The study found that blocking patents were frequently used to extract licensing revenue or to force inclusion in cross-licensing negotiations.[205] For instance, a patent holder with no intent of commercializing the complex product may want to extract rents through licensing. Moreover, "incumbents can use their patents

[199] Roberto Mazzoleni & Richard R. Nelson, *The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate*, 27 RES. POL'Y 273, 275 (1998) (citing Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit in Sequential Innovation*, 26 RAND J. ECON. 20 (1995); Suzanne Scotchmer & Jerry Green, *Novelty and Disclosure in Patent Law*, 21 RAND J. ECON. 131 (1990)).

[200] Knut Blind & Nikolaus Thumm, *Interrelation Between Patenting and Standardisation Strategies: Empirical Evidence and Policy Implications*, 33 RES. POL'Y 1583, 1587 (2004).

[201] *Id.*

[202] *Id.* (citing OVE GRANSTRAND, THE ECONOMICS AND MANAGEMENT OF INTELLECTUAL PROPERTY (1999)).

[203] *Id.* at 1583, 1588–89.

[204] Wesley M. Cohen, Richard R. Nelson & John P. Walsh, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* 4, 17, 22 (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000).

[205] *Id.* at 17.

as bargaining chips . . . [to] secure the freedom to move ahead on similar technological efforts without being sued" in a sort of "block to play" strategy.[206] "For example, in the 1940's du Pont patented over 200 substitutes for Nylon to protect two of its core invention."[207]

Patent blocking can create an "anticommons" where resources are prone to underuse as owners exclude others from accessing certain inventions.[208] Patents and IPR protection "may fortify incentives to undertake risky research . . . , [but] . . . can go astray when too many owners hold rights in previous discoveries that constitute obstacles to future research."[209] Here, patents may be increasingly viewed as entitlements, resulting in "a spiral of overlapping patent claims in the hands of different owners."[210] "By conferring monopolies in discoveries, patents necessarily increase prices and restrict use—a cost society pays to motivate invention and disclosure . . . Each upstream patent allows its owner to set up another tollbooth on the road to product development, adding to the cost and slowing the pace of downstream . . . innovation."[211] Additionally, "[t]he phenomenon of 'winner take all' has resulted in an unprecedented period of business consolidation, producing oligarchies in key technology and research-based industries."[212]

For instance, the fuel cell manufacturing industry involves many different firms with varying licenses to facilities and royalties. Participants at a fuel cell plant in Santa Clara, California included the Electric Power Research Institute, United Power Association, National Rural Electric Cooperative Association, Sacramento Municipal Utility District, Southern California Edison, the California Energy Commission, City of Palo Alto, Arizona Salt River Project, Fuel Cell Engineering Corporation, and the U.S. Department of Energy.[213] The complex series of agreements required to get the project off the ground

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[206] *Id.* at 22.

[207] *Id.* (citing DAVID A. HOUNSHELL & JOHN KENLY SMITH JR., SCIENCE AND CORPORATE STRATEGY: DU PONT RESEARCH AND DEVELOPMENT, 1902–80 (1988)).

[208] *See generally* Heller & Eisenberg, *supra* note 86, at 698.

[209] *Id.*

[210] *Id.*

[211] *Id.* at 699 (discussing biomedical patents).

[212] KRAEMER, *supra* note 8, at 251.

[213] A. J. Appleby, *Fuel Cell Technology: Status and Future Prospects*, 21 ENERGY 521, 580–81 (1996).

took years to negotiate.[214]

In parallel, significant mergers have resulted in the unprecedented consolidation of the global wind energy industry. In 2004, four manufacturers—General Electric, Vestas, Enercon, and Gamesa—were responsible for three-quarters of global wind turbine sales.[215] The Danish company Vestas is so large that it made 33,500 wind turbines by June 2007, installing one somewhere in the world every five hours, and produced nacelles in seven countries around the world and blades in seven others during 2006.[216] However, such consolidation creates "a major disincentive for leading wind manufacturers to license proprietary information to companies that could become competitors."[217] Vestas, for example, licensed its turbine technology to Gamesa, but now must compete with it on the world market.[218] General Electric seems to have learned this lesson and uses a 1992 patent on variable speed technology for wind turbines to prevent entry into the American wind market until the patent expires in 2009.[219]

Similar complexities occur in carbon sequestration and storage research, where property rights concerning access to project sites are not clearly defined, especially when development relies on different areas of technology (including at the surface injection

214 *Id.* at 581.

215 Joanna Lewis & Ryan Wiser, Fostering a Renewable Energy Technology Industry: An International Comparison of Wind Industry Policy Support Mechanisms 4 (Nov. 2005) (unpublished manuscript, on file with the Ernest Orlando Lawrence Berkeley National Laboratory), *available at* http://eetd.lbl.gov/ea/emp/reports/59116.pdf (citing Press Release, BTM Consult ApS, International Wind Energy Development: World Market Update 2004 Forecast 2005–2009 (Mar. 31, 2005), *available at* http://www.rechsteiner-basel.ch/uploads/media/btm_Pressrelease.pdf).

216 Press Release, Vestas Wind Systems A/S, Vestas at World Economic Forum to Promote Modern Energy (Jan. 22, 2008), *available at* http://vestasirap.ms-serv.com/download_file.php?myfile=Vestas_annual_report_2006_150.pdf; VESTAS, VESTAS ANNUAL REPORT (2007), *available at* http://www.vestas.com/en/investor/financial-reports.aspx (follow "Annual Report" hyperlink under "2007 Reports").

217 Lewis & Wiser, *supra* note 215, at 5.

218 *Id.*

219 *See* U.S. Patent No. 5,155,375 (filed Sept. 19, 1991); GE Complains to U.S. Trade Body about Mitsubishi Heavy, MSN Money, Mar. 7, 2008, http://news.moneycentral.msn.com/provider/providerarticle.aspx?feed=OBR&date=20080307&id=8298407; Nicola Tatchell, *A Change in the Wind*—General Electric Co v. Enercon GmbH and Others, MONDAQ BUS. BRIEFING, Apr. 27, 2004, *available at* http://www.mondaq.com/article.asp?article_id=25623.

level, at the sub-surface reservoir level, and where the CO_2 is physically deposited).[220] "Most clean coal technologies require multiple patents in many different fields. Companies working on fluidized combustion technology, for instance, must invent or license patents relating to combustion dynamics, fluid dynamics, air dynamics, material science, computational controls, and electronics."[221] One study on carbon sequestration concluded that "institutes and universities involved are too worried about losing their technical advantages or intellectual property rights to cooperate effectively with each other."[222]

It appears that parts of the American automobile industry are similarly fractured. Ford has resisted purchasing Toyota's technology for hybrid vehicles because of hefty licensing fees and Honda has not been able to successfully negotiate a license to use nickel metal halide batteries in its hybrid vehicles.[223]

D. Industry-Government-University Partnerships

As mentioned earlier, CRADAs are a form of contract encouraging industries, universities, and government laboratories to work on developing new technologies together.[224]

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[220] KATE ROBERTSON, JETTE FINDSEN & STEVE MESSNER, DOE/NETL-2006/1236, INTERNATIONAL CARBON CAPTURE AND STORAGE PROJECTS: OVERCOMING LEGAL BARRIERS 5, 10 (National Energy Technology Laboratory 2006), *available at* http://www.netl.doe.gov/energy-analyses/pubs/CCSregulatorypaperFinalReport.pdf.

[221] CARBON LOCK-IN, *supra* note 71, at 75.

[222] YUNHUI JIN & XUE LIU, CLEAN COAL TECHNOLOGY ACQUISITION: PRESENT SITUATION, OBSTACLES, OPPORTUNITIES AND STRATEGIES FOR CHINA 76 (1999), *available at* http://www.iisd.org/pdf/cleancoalttgsm.pdf.

[223] Telephone interview with David Greene, Corporate Fellow, Ctr. for Transp. Analysis, Oak Ridge Nat'l Lab. (Oct. 31, 2006).

[224] CRADAs allow federal laboratories to conduct research in partnership with non-federal organizations, such as firms, universities, and state and local governments. Such agreements require the prior settlement of any intellectual property created by the research in a way that is relatively favorable to all partners. Under such agreements, the laboratory and the industrial or university partner share the intellectual property brought into and created through the CRADA activity. Technical data produced under the CRADA are protected from disclosure for five years after the CRADA is completed. The industrial partner has title to all patents resulting from its own efforts under the CRADA. The laboratory contractor retains rights to inventions developed by the laboratory under the CRADA, but the partner is guaranteed an option on an exclusive license in a negotiated field of use for royalties. *See* FED. LAB. CONSORTIUM FOR TECH. TRANSFER, FLC TECHNOLOGY TRANSFER DESK REFERENCE ch. 3 (2006), *available at* http://www.federallabs.org/pdf/T2_Desk_Reference.pdf (describing the philosophy underlying CRADAs).

Another class of IPR barriers relates to the many different components of the CRADA process, including how industries and universities perceive each other and government laboratories.

For instance, a small number of businesses and industrial leaders are reluctant to cooperate with universities because they perceive the universities as lax in accounting, abusive of government regulations of indirect cost allowances and overhead, and lacking an entrepreneurial ethic.[225] "Congress has also criticized research universities for their collaborative relations with foreign-affiliated corporations and for their encouragement of the growth in the number of foreign nationals participating in publicly supported academic research."[226] Similarly, some universities are "seen as lacking business and marketing expertise or structuring their work in a manner difficult to manage."[227]

While the exception and not the rule, industry has expressed some concern towards having to pay royalties to access and use technology from the national laboratories. The DOE contractor-operated laboratories (unlike government employee operated laboratories of other federal agencies) can "more readily offer exclusive licenses to technologies arising at the laboratory."[228]

Nonetheless, many industrial leaders believe that since their taxes fund government research, they should not have to pay "twice" for it through a license or royalty . . . [O]ther potential partners have expressed frustration with the preference for collaborating in laboratory CRADAs with companies that agree that to manufacture CRADA-produced technologies in the United States. This can be a disincentive to partnering with a DOE laboratory,[229] although the DOE does attempt to mitigate such constraints through negotiation.

In parallel, most businesses working on new technologies need

[225] *See* Harvey Brooks, *Research Universities and the Social Contract for Science*, *in* EMPOWERING TECHNOLOGY: IMPLEMENTING A U.S. STRATEGY 202, 204 (Lewis M. Branscomb ed., 1993).

[226] *Id.* at 204–05.

[227] Brian Rappert et al., *Making Sense of Diversity and Reluctance: Academic-Industrial Relations and Intellectual Property*, 28 RES. POL'Y 873, 881 (1999).

[228] CARBON LOCK-IN, *supra* note 71, at 77 (citing Telephone interview with Paul A. Gottlieb, Assistant Gen. Counsel for Tech. Transfer and Intellectual Prop., U.S. Dep't of Energy (Nov. 28, 2006)).

[229] *Id.* (citing Telephone interview with Paul A. Gottlieb, Assistant Gen. Counsel for Tech. Transfer and Intellectual Prop., U.S. Dep't of Energy (Nov. 28, 2006)).

rapid payback schedules, so their short term R&D objectives do not always match with the more long-term objectives of the DOE.[230] While admittedly rare, "[s]ome elements of the private sector have expressed frustration in dealing with the laboratories" due to the high cost and excessive delay associated with administering CRADAs.[231] "The process of bringing a new product to market involves the most intimate of relationships between buyer and seller," but the DOE has sometimes been perceived as "too a clumsy [sic] partner to enter into this relationship in a meaningful way."[232]

Consequently, some firms "are highly skeptical that the laboratories possess either the culture (sensitivity to cost and market requirements) or the experience (in process technology, design for manufacturability, and the like) necessary to make a contribution to commercial success."[233] "[L]aboratory managers are subject to diverse . . . [levels of] bureaucratic accountability; their programs are determined by multiple functional offices in DOE headquarters."[234] Both pressures make them unresponsive to decentralized decisions required by small businesses and contribute to the perception that CRADAs will be excessively micromanaged, inflexible, and intrusive.[235]

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[230] John A. Herrick, *Federal Project Financing Incentives for Green Industries: Renewable Energy and Beyond*, 43 NAT. RESOURCES J. 77, 99 (2003), *available at* http://www.law.du.edu/herrick/Web_Links_Legal_Writings/NaturalResources.pdf.

[231] *Id.* at 100 n.97.

[232] Robert W. Fri, *From Energy Wish Lists to Technological Realities*, ISSUES SCI. & TECH., Fall 2006, at 63, *available at* http://www.issues.org/23.1/fri.html.

[233] Lewis M. Branscomb, *National Laboratories: The Search for New Missions and New Structures*, *in* EMPOWERING TECHNOLOGY: IMPLEMENTING A U.S. STRATEGY 103, 113–14 (Lewis M. Branscomb ed., 1993).

[234] *Id.* at 114.

> [T]he sheer complexity of the national laboratories may deter collaboration. The quality of laboratory technology and competency may differ, reflecting the nature of disparate laboratory missions (those specializing in basic science or defense may have less experience with and facilities for commercialization). Moreover, the conditions under which contractors can be permitted to patent and license federally funded technologies remains highly controversial, and the relationship between contractors assigned to run facilities and the DOE differs significantly. The locations of the facilities at the national laboratories are highly disparate, some placed near population centers while others exist in highly remote areas.

CARBON LOCK-IN, *supra* note 71, at 77 (citing Jaffe & Lerner).

[235] *See* Branscomb, *supra* note 233, at 114. It should be noted, however, that DOE does have a very good record in collaborating with businesses at large. For instance,

One study found that while more than eighty percent of partners were pleased with the DOE, 11 percent of companies were dissatisfied with CRADAs.[236] The study revealed that a small number of industrial managers were concerned that CRADAs excluded smaller companies, which could not afford the luxury of expending financial and human capital on CRADAs, and that laboratory expertise was more focused on upstream, rather than downstream work.[237] Thus, the national laboratories are perceived as excellent for basic research, but sometimes lacking expertise on commercialization and deployment.

Finally, a shift to more university patenting has provoked a discussion among scientists and academics about the role of the university. The controversy centers on how to prevent the commercialization of university research from undermining the central commitment to the sharing of knowledge. Many scientists and professors, for instance, believe that teaching and research depend on the absence of barriers to the free and open exchange of knowledge.[238] Openness, then, is not just needed to discover and promote truth, but also to recognize quality and distinguish it from mediocrity. Many academics believe that openness is needed to:

[F]acilitate[] independent replication of findings; promote[] swift generalization of results; avoid[] excessive duplication of research; increase[] the probability of [innovation] arising from

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> [i]n FY 2006, DOE and its laboratories and facilities negotiated and executed 12,437 technology transfer-related transactions. These transactions included 631 new or active Cooperative Research and Development Agreements (CRADAs); 2,416 Work-for-Others Agreements involving non-Federal entities (NFEs); 5,916 licenses of intellectual property; and 3,474 user facility agreements. In addition, DOE national laboratories and facilities disclosed 1,694 inventions; filed 726 patent applications; were issued 438 patents; and logged more than 351,000 downloads of their copyrighted open-source software.

OFFICE OF POL'Y & INT'L AFFAIRS, U.S. DEP'T OF ENERGY, REPORT ON TECHNOLOGY TRANSFER AND RELATED TECHNOLOGY PARTNERING ACTIVITIES AT THE NATIONAL LABORATORIES AND OTHER FACILITIES, FISCAL YEAR 2006 4 (2007), *available at* http://www.llnl.gov/IPandC/news/specialreports/FY2006AnnualReportonTTfinal.pdf. The extent of this work is a reflection of the continued confidence in DOE on the part of thousands of private partners who work with DOE in these ways.

[236] MICHAEL CROW & BARRY BOZEMAN, LIMITED BY DESIGN: R&D LABORATORIES IN THE U.S. NATIONAL INNOVATION SYSTEM 205 (1998).

[237] *See id.* at 202–04.

[238] *See, e.g.*, Robert M. Rosenzweig, *Research as Intellectual Property: Influences within the University*, 10 SCI., TECH., & HUM. VALUES 41, 41–42 (1985) (explaining the importance of open communication to education in a university setting).

novel and unanticipated combinations . . . ; [and] raise[] the social value of knowledge by lowering the chance that [knowledge] will reside with persons and groups who lack the resources and ability to exploit it.[239]

Disputes between faculty members and university administrators seeking to commercialize academic research can become more than just theoretical debates. . . . [C]onflagrations between faculty members who prefer an open or accessible license for discovery (which would maximize the breadth of knowledge dissemination in their mind) and entrepreneurial universities (that want a more lucrative, exclusive license) can turn into protracted, legal battles. A 199[6] case in California[240] illustrates the financial danger of such conflicts. Two professors won a $2.3 million . . . award from the University of California-San Francisco after claiming the university defrauded them by licensing their patents to other companies at a discount in exchange for sponsored research support from those companies.[241]

Intellectual property concerns are further complicated by the recent erosion of the common law research exemption. Basic scientific research that uses patented inventions has long been considered immune from patent infringement suits due to the "experimental use," or "research," exception. This exemption dates back to the 1813 case, *Whittemore v. Cutter*, where Justice Story noted that basic research that lacked commercial intent did not constitute a patent-infringing activity.[242] This exception was repeated in *Ruth v. Stearns-Roger Mfg. Co.*, where the Colorado

[239] Dominique Foray, *Generation and Distribution of Technological Knowledge: Incentives, Norms, and Institutions*, *in* SYSTEMS OF INNOVATION: TECHNOLOGIES, INSTITUTIONS, AND ORGANIZATIONS 64, 66 (Charles Edquist ed., 1997); *see also* Nicholas S. Argyres & Julia Porter Liebeskind, *Privatizing the Intellectual Commons: Universities and the Commercialization of Biotechnology*, 35 J. ECON. BEHAV. & ORG. 427, 431 (1998); Aldo Geuna & Lionel Nesta, *University Patenting and Its Effects on Academic Research: The Emerging European Evidence*, 35 RES. POL'Y (forthcoming 2006) (manuscript at 3), *available at* http://www.epip.eu/papers/20041001/paris/papers/Geuna.pdf; Donald Kennedy, *Science and Secrecy*, 289 SCI. 724, 724 (2000), *available at* http://www.sciencemag.org/cgi/content/summary/289/5480/724?ck=nck.

[240] Singer v. Regents of Univ. of Cal., No. 950381, 1996 WL 604519 (Cal. Super. Ct. July 19, 2006).

[241] CARBON LOCK-IN, *supra* note 71, at 78 (citing Walter W. Powell & Jason Owen-Smith, *Universities and the Market for Intellectual Property in the Life Sciences*, 17 J.POL'Y ANALYSIS & MGMT. 253, 270–71 (1998)).

[242] Moore, *supra* note 41, at 158 (quoting Whittemore v. Cutter, 29 F. Cas. 1120, 1121 (C.C.D. Mass. 1813)).

District Court stated that "making or using [a product infringing on a patent] . . . without any intent to derive profits or practical advantage . . . is not infringement."[243]

Such an exemption, however, has recently come under scrutiny. In *Pitcairn v. United States*, the patent rights of rotary-wind aircraft were deemed to be infringed when researchers at another organization attempted to test a similar prototype.[244] *Madey v. Duke University* further limited the experimental research defense since the court stated that if the allegedly infringing act furthers business interests in any way (and is not for amusement, to satisfy curiosity, or for philosophical inquiry), then it does not meet the defense.[245] Thus, it remains unclear whether the exemption still exists, and whether universities could be more vulnerable to litigation for undertaking basic scientific experiments. "Understanding whether the common law exception continues to exist or not is tremendously important to modern science. Virtually no significant research today is performed by any entity devoid of 'legitimate business interests.'"[246] Limited exceptions to infringement are fundamental to prevent the tragedy of the anti-commons elaborated on above.

E. International Impediments

While this article has primarily focused on domestic IPR barriers to clean energy technologies, weak IPR protections internationally are often cited by U.S. technology firms as a significant impediment to both deciding to develop an innovative technology and to diffusing that technology into the global marketplace.

Concerns about weak IPR protection in international countries can deter innovation, as firms believe they would be at a competitive disadvantage to distribute their technology. Also, many companies do not want to collaborate with overseas partners because "[p]articipation may attract those that have the most to gain and . . . the least to contribute," risking an

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[243] *Id.* at 158–59 (quoting Ruth v. Stearns-Roger Mfg. Co., 13 F. Supp. 697, 713 (Dist. Ct. Colo. 1935), *rev'd*, 87 F.2d 35 (10 Cir. 1936)).

[244] *Id.* at 159–60 (citing Pitcairn v. United States, 547 F.2d 1106, 1125–26 (Ct. Cl. 1976)).

[245] *Id.* at 164 (citing Madey v. Duke Univ., 307 F.3d 1351, 1362 (Fed. Cir. 2002)).

[246] *Id.* at 169–70.

asymmetrical relationship where sharing is uneven between firms.[247] Moreover, host companies in developing countries may be reluctant to purchase or acquire technology that they believe competitors could freely copy in their own markets.[248] Thus, weak international IPR protection affects both the supply and demand components of technological diffusion. Such barriers have been found to affect efficient industrial boilers, fluidized bed combustion, coal gasification, and various end-of-pipe pollution abatement technologies such as carbon capture and storage.[249]

Weak IPR protection has prevented U.S. companies from developing more advanced clean coal technologies, such as more efficient coal washing processes, advanced combustion turbines, and carbon capture and storage systems.[250] IPR concerns connected with clean coal systems are cited as one of the most significant impediments towards diffusing such technologies to China, Indonesia, and other developing countries—especially where new technologies could be reverse engineered or copied.[251]

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[247] Organisation for Economic Co-operation and Development [OECD] & Int'l Energy Agency [IEA], *International Energy Technology Collaboration and Climate Change Mitigation: Synthesis Report*, at 8, Doc. COM/ENV/EPOC/IEA/SLT(2005)11 (Nov. 2005), *available at* http://www.iea.org/Textbase/papers/2005/cp_synthesis.pdf [hereinafter *Synthesis Report*].

[248] *Synthesis Report*, *supra* note 247, at 11(citing Jin & Liu, *supra* note 222, at 63).

[249] *Synthesis Report*, *supra* note 247, at 11, 25 (describing the results of a case study of "clean coal collaboration in China").

[250] *See* Turlough F. Guerin, *Transferring Environmental Technologies to China: Recent Developments and Constraints*, 67 TECHNOLOGICAL FORECASTING & SOC. CHANGE 55, 64, 73 (2001) (noting that the lack of IPR laws and enforcement in China is a barrier to the transfer of technology from the U.S. to China); Int'l Energy Agency [IEA], *International Energy Agency Technology Collaboration and Climate Change Mitigation: Case Study 4: Clean Coal Technologies*, at 26, IEA Doc. COM/ENV/EPOC/IEA/SLT(2005)4 (Apr. 28, 2005), *available at* http://www.iea.org/textbase/papers/2005/cp_clean_coal.pdf [hereinafter *Case Study 4: Clean Coal Technologies*]; Telephone interview with Diana Kruger, Dir., Climate Change Div., EPA (Nov. 8, 2006); Telephone interview with Paul Gunning, Chief of the Non-CO2 Programs Branch, Climate Change Div., EPA (Nov. 8, 2006); Telephone interview with Susan Hovorka, Research Scientist, Bureau of Econ. Geology, Univ. of Tex. (Nov. 14, 2006).

[251] *See Case Study 4: Clean Coal Technologies*, *supra* note 250, at 26; OFFICE OF THE U.S. TRADE REPRESENTATIVE, EXECUTIVE OFFICE OF THE PRESIDENT, REPORT BY THE OFFICE OF THE UNITED STATES TRADE REPRESENTATIVE ON TRADE-RELATED BARRIERS TO THE EXPORT OF GREENHOUSE GAS INTENSITY REDUCING TECHNOLOGIES 2, 6 (2006), *available at* http://www.ustr.gov/assets/Document_Library/Reports_Publications/2006/asset_upload_file288_9874.pdf [hereinafter OFFICE OF THE U.S. TRADE REPRESENTATIVE]; Telephone interview with Diana Kruger, *supra* note 250;

Such international barriers apply not just to clean coal systems. Research on pollution abatement technologies for sulfur dioxide and nitrogen oxide emissions in the U.S. has been slowed by a perceived need to adapt technologies to local markets.[252] While U.S. exports of renewable energy and air pollution control technologies, currently totaling more than $18 billion in 2005, are eligible as environmental goods for reduced tariffs under the World Trade Organization, lack of adequate and effective IPR protection in Venezuela, Uzbekistan, Philippines, Columbia, China, and Chile prevented much needed investment in such technologies.[253] "U.S. firms are hesitant to diffuse hydrogen technology even in Europe due to lack of consistent rules and regulations involving IPR."[254]

IV. POTENTIAL SOLUTIONS

To respond to the assortment of barriers related to intellectual property and technological development, legislative and judicial action may be justified.

A. Overcoming High Transaction Costs

As its most basic level, lawmakers must make patent law simple, objective, and transparent. The U.S. has too much complexity in its patent law in part because, as time has gone by, the government has attempted to reform the patent system by adding things to it. More than 200 years of judicial decisions have afforded the courts the opportunity to engraft new doctrines onto patent law, then refine and nuance them. Consequently, the U.S. has been accused of having "the most non-transparent patent system anywhere in the world."[255] In response, cross-licenses, organizational reform at the USPTO, streamlined patent reexamination guidelines, non-exclusive and compulsory

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Telephone Interview with Paul Gunning, *supra* note 250; Telephone interview with Susan Hovorka, *supra* note 250.

[252] David Popp, *International Innovation and Diffusion of Air Pollution Control Technologies: The Effects of NOX and S02 Regulation in the U.S., Japan, and Germany* 30–31, (Nat'l Bureau of Econ. Research, Working Paper No. 10643, 2006).

[253] *See* OFFICE OF THE U.S. TRADE REPRESENTATIVE, *supra* note 251, at 2, 5, 6 (2006).

[254] CARBON LOCK-IN, *supra* note 71, at 76 (citing Barry D. Solomon & Abhijit Banerjee, *A Global Survey of Hydrogen Energy Research Development and Policy*, 34 ENERGY POL'Y 781, 787 (2006)).

[255] Armitage, *supra* note 155, at 280.

licensing, suppression justification, pre-publication, patent pools, "obligations to use," an explicit research exemption, and trade agreements have been proposed as potential remedies to some of the IPR barriers discussed in this article.[256]

To respond to some of the structural problems related to high transaction costs and cognitive bias among researchers, *cross-licenses*, or the mutual sharing of patents among companies, can help "cut through the patent thicket."[257] Such collaboration brings with it manifold benefits relating to (a) "the ability of participating firms to lower costs and spread risks," (b) a reduction in the "duplication in [ ] R&D investments," and (c) better "exploitation of economies of scale in the R&D process."[258]

For the moment, cross-licensing faces two obstacles: coordination costs (in terms of time and money) and anti-trust sensitivities. Cross-licensing reduces diversity in the research process, which is a needed hedge against the possibility that a single, cooperative "project will be fruitless."[259] Members of a consortium or patent pool can drop out, leave, change corporate strategy, or become acquired by a firm that no longer wants to continue collaboration.[260] Additionally, some firms fear that knowledge spillovers can necessitate firms "to resist knowledge-sharing within a consortium." Consortium design and management must also overcome a host of barriers related to reaching a shared "definition of the research agenda and choice of projects; [procedural problems related to the] transfer of research results to participants; and adaptation to change in the economic and technological environment."[261]

Furthermore, anti-trust concerns "are invariably heightened when companies in the same or related lines of business combine their assets, jointly set fees of any sort, or even talk directly with one another."[262] "Anti-trust law and enforcement" concerns, as well as perceived "historical hostility to[wards] cooperation

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256 CARBON LOCK-IN, *supra* note 71, at 132.

257 *Navigating the Patent Thicket*, *supra* note 78, at 119.

258 Peter Grindley, David C. Mowery & Brian Silverman, *SEMATECH and Collaborative Research: Lessons in the Design of High-Technology Consortia*, 13 J. POL'Y ANALYSIS & MGMT. 723, 725 (1994).

259 *Id.* (citing William M. Evan & Paul Olk, *R&D Consortia: A New U.S. Organizational Form*, 31 SLOAN MGMT. REV. 37, 40–41 (1990)).

260 William M. Evan & Paul Olk, *R&D Consortia: A New U.S. Organizational Form*, 31 SLOAN MGMT. REV. 37, 44 (1990).

261 Grindley, Mowery & Silverman, *supra* note 258, at 726.

262 *Navigating the Patent Thicket*, *supra* note 78, at 126.

among . . . rivals," can act as a deterrent to innovation and collaboration.[263] Cross-licensing agreements can especially raise anti-trust concerns when they involve a dominant firm with strong patents. "If the dominant firm [refuses to license], then anti-trust enforcers face the difficult task of determining whether the refusal [constitutes] anti-competitive [behavior] or simply [represents] the legal exercise of intellectual property rights."[264]

Organizational reforms at the USPTO may be warranted. "[Patent examiners] need legal training and experience in applying that training to complex technologies . . . a thorough understanding of patentability requirements and their application . . . [and] technical expertise in the field of the invention—or [at least] someone to [assist and] guide them . . ."[265] The USPTO could increase the amount of testing it undertakes of employee skills and create more certification exams to respond to some of these concerns.[266]

Since small firms do not have resources to overcome many of the transaction costs associated with protecting their patents, a *streamlined patent examination process* could be created. "Reexamination provides a low-cost alternative to litigation" because it can be undertaken by providing a written request to the USPTO to reexamine a patent's validity.[267]

B. Overcoming Anti-Competitive Patent Techniques

To respond to anti-competitive patent practices, such as submarine patents, suppression, and patent blocking, Congress can force companies to create *nonexclusive* or *compulsory* licenses for products that have a significant public health benefit. "Section PP5-6 of the World Trade Organization's Declaration on Trade Related Aspects of Intellectual Property (TRIPS) supports the ability [of] governments to compulsory license products in furtherance of public interest." The idea is also supported by the United Nation's Agenda 21.[268] The U.S. has used compulsory licensing before, in 1956, to require "the American Telephone and

[263] *Id.* at 119.
[264] Gallini, *supra* note 87, at 143.
[265] Armitage, *supra* note 155, at 287.
[266] *Id.*; Philipp, *supra* note 141, at 120.
[267] Amy L. Magas, Comment, *When Politics Interfere With Patent Reexamination*, 4 J. MARSHALL REV. INTELL. PROP. L. 160, 162 (2004), *available at* http://www.jmripl.com/Publications/Vol4/Issue1/magas.pdf.
[268] CARBON LOCK-IN, *supra* note 71, at 132 n.79.

Telegraph Company and International Business Machines to cross-license their fundamental patents to all qualified applicants at reasonable fees."[269] "[A] court could compel licensing [in the energy sector] if (1) it finds that a patentee has suppressed a patent with the purpose to unduly restrain trade or lessen competition and that (2) the alleged competitive harm stems from the nonuse and refusal to license."[270] This would ultimately change the conception of a patent from a form of innovation or reward to a social contract between patentee and society.

The courts could also force firms to provide a *justification* for the suppression of novel energy technologies. "[A] patentee that chooses not to use or license its patent is currently under no obligation to justify this decision."[271] Yet, if the patentee were required to do so, the patentee would have to admit to nonuse and refusal to license, and then advance a reason to the public as to why it has made these decisions.

The *pre-publication* of patent applications would help deter submarine patents, and provide "a source of technical information for businesses and inventors on recently filed U.S. applications."[272]

Patent pools may help reduce patent blocking. Such pools occur when two or more companies control patents, but at least some of the potential manufacturers do not hold licenses to use such patents. A patent pool incorporates an entire group of patent holders so that they operate according to a single license, or "jointly license their complementary patents and divide up the proceeds."[273] One classic example is the creation of the Manufacturers Aircraft Association "in 1917 to license a number of patents necessary for the production of airplanes" (patents had previously been controlled separately by "The Wright-Marin Aircraft Corporation, the Curtiss Aeroplane & Motor Corporation, and others").[274] More recently, the Department of Justice has approved patent pools necessary for the diffusion of MPEG-2 video compression technology and Digital Versatile Disk

[269] Davis, *supra* note 31, at 406.
[270] Saunders, *supra* note 183, at 435.
[271] *Id.* at 429.
[272] Blount, *supra* note 163, at 28.
[273] *Navigating the Patent Thicket*, *supra* note 78, at 127.
[274] *Id.* at 127–28.

(DVD).[275]

As a potential solution to suppression and patent blocking, Germany has initiated an "*obligation to use*" mandate for all new trademarks, [276] which could just as well apply to patents. The requirement drastically cut down on the number of trademark applications, triggering relief for the German Patent Office and the Federal Patent Court, and restricted the incidence of warehousing and suppression. The requirement was also intended to increase the efficiency of German innovation in science and technology, since trademarks were only issued to proprietors who were diffusing their goods or services into the marketplace. The obligation prevents proprietors from enforcing their trademark rights if they do not use the trademarks within five years of registration. Further, any person has standing to seek legal action for cancellation of a trademark that has not been used. "This provision, which eliminates deadwood from the [German] register, serves the public interest and minimizes the number of possible conflicts between existing [trade]marks."[277]

To address the legal uncertainty over the common law research exemption, Congress could simply amend Bayh-Dole to provide an "*academic research exemption*."[278] This could state that patents derived from federally-funded research could be subject to a compulsory license, such that anyone performing federally-funded research could use the patented invention. "In other words, the pool of patents derived from government-funded inventions would be freely available to government-sponsored researchers. Owners of such patents . . . would remain free to license their inventions to third parties outside the stream of federal funding for further commercial development."[279] Such an amendment would devalue patents within academia, but maintain their commercial viability in the public sector.[280]

To overcome weak international IPR protection, *bilateral or*

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[275] Gallini, *supra* note 87, at 143.

[276] Rudolf Rayle, *The Trend Towards Enhancing Trademark Owners' Rights—A Comparative Study of U.S. and German Trademark Law*, 7 J. INTELL. PROP. L. 227, 267–68 (2000) (citing Gesetz ber den Schutz von Marken und sonstigen Kennzeichen (Markengesetz) [The German Trademark Act of 1995] §§ 25, 49(1), 55(1)–(2) v. 25.10.1994 (BGBl. I S.3082), as amended, *translated in* Martin Aufenanger & Gerald Barth, Markengesetz/The German Trademark Act (1996) [hereinafter German Trademark Act]).

[277] *Id.* at 268.

[278] Moore, *supra* note 41, at 170 (emphasis added).

[279] *Id.* at 170–71.

[280] *Id.* at 171.

multilateral trade agreements could be created to complement and enhance international standards for the protection of intellectual property rights.[281]

Naturally, not all of these actions may be needed or even be desirable. But policymakers must move beyond asking whether intellectual property laws and standards need modification to promote alternative energy technologies—they do—to how we should change them.

V. CONCLUSION

Admittedly, many of the IPR barriers facing clean energy technologies do not hold equal weight and some inherently contradict with others. For example, small firms often cite the strength of current patent laws as a deterrent to innovation, where large multinational firms believe that domestic and international protections for IPR need to be strengthened.[282] Industry leaders view some universities as lacking the proper entrepreneurial ethic needed to promote innovative technologies, where some universities view the commercialization of academic research as a threat to their core educational mission.[283]

Moreover, an important tension exists between the claim that patents are becoming too broad and the claim that such patents have significant commercial impact. If a patent is obviously invalid or almost sure to be found invalid if litigated, that patent should have little or no commercial impact. In equilibrium of the "patent litigation and settlement game," two key patterns should emerge: (a) "litigated patents should be of relatively high commercial significance[,] [o]therwise the litigation costs would not be worth incurring"; and (b) "the outcomes of patent litigation, . . . occurs,] should be highly unpredictable," for if the outcome were easily predicable, one would expect settlement.[284] "[Such] arguments tell us that the problems with the patent system . . . do not primarily fit the picture often painted [of] absurd or obviously invalid patents being brandished by non-inventors who are exploiting the patent system to extract royalties from upstanding companies who are the true

[281] *See* OFFICE OF THE U.S. TRADE REPRESENTATIVE, *supra* note 251, at 2–3, 24–31 (discussing negotiations to address international trade barriers).

[282] *See* discussion *supra* Part II.A.

[283] *See supra* note 225 and accompanying text.

[284] Shapiro, *supra* note 74, at 1033.

innovators."[285]

Instead, the inherent tension between intellectual property and innovation reveals a deeper complex of problems that require concerted action to address. Such problems appear to be constituted from the following basic elements:

High transaction costs associated with obtaining and enforcing a patent, coupled with cognitive biases among patentees and asymmetries in the distribution of information;

A USPTO that lacks sufficient resources to handle the growing number of patents, and whose expertise and knowledge of prior art can easily lag behind industry in areas where technology is rapidly advancing;

The danger that a company developing, designing, and even manufacturing a new product will be unaware of many patents, which can then be asserted opportunistically against its products after it has made significant investments;

Intentional suppression or non-use of patents or the use of patents as a tool to further anti-competitive behavior; and/or

Disintegrating relationships between a small number of university-industry-government partners, including growing frustration with CRADAs and the erosion of the common law research exemption.

To respond, a variety of policy mechanisms is needed to improve the efficiency of the American patent system and offer alternatives to criminalization and litigation. More patent pools could be encouraged to reduce transaction costs. Organizational reform and increased funding for the USPTO could help improve the quality of patents being issued. Compulsory licensing could be mandated to reduce patent suppression. The academic research exemption could be reintroduced to further incentivize basic research.

Yet, contrary to this line of thought, no area of criminal law has experienced more growth in recent years than intellectual property. In the past two decades, Congress has made trademark counterfeiting and copyright violation predicate acts under both money laundering and RICO statutes with the Anti-Counterfeiting Consumer Protection Act of 1996;[286] broadened the scope of criminal liability for copyright infringement under

[285] *Id.*

[286] Anti-Counterfeiting Consumer Protection Act of 1996, Pub. L. No. 104-153, 110 Stat. 1386.

the Copyright Felony Act of 1992;[287] criminalized trademark infringement under the Trademark Counterfeiting Act of 1984;[288] imposed criminal liability for the manufacture and sale of devices that can be used to circumvent technological protection measures under the Digital Millennium Copyright Act of 1998 ;[289] and criminalized the theft of trade secrets under the Economic Espionage Act of 1996.[290]

Perhaps incongruously, the transition to more university-industry-government partnerships and towards stronger patents may partially impede innovation and the diffusion of innovative energy technologies, especially since many companies no longer patent with the primary goal of inducing innovation.

> [F]irms apply for patents . . . for many reasons beyond providing the incentive to create new products and processes: to block or 'enclose' rivals (preventing them from pursuing a given line of patented research), signal plans to enter a new technological area or market, facilitate cross-licensing, indicate stock market value, [gain reputation or prestige,] or enable the evaluation of business prospects for mergers or acquisitions. Numerous patents are taken out for defensive reasons: to ensure that no-one else patents them, and to secure freedom to operate.[291]

For example, a study of the patenting behavior of U.S. semiconductors found that several firms were ramping up their patent portfolios or harvesting latent inventions not to make money or innovate, but to add to their stock of patents (and thus prestige), protect themselves from being shut down through an injunction (like the famous Kodak-Polaroid case), and create bargaining chips to be used in negotiations with competitors or smaller firms.[292] There is good reason to suggest that the semiconductor industry is similar to the energy industry, since in both sectors firms engage in rapidly advancing, cumulative technologies, and must confront numerous patents to advance a single technology.

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[287] Copyright Felony Act of 1992, Pub. L. No. 102-561, 106 Stat. 4233.

[288] Trademark Counterfeiting Act of 1984, Pub. L. No. 98-473, 98 Stat. 2178.

[289] Digital Millennium Copyright Act of 1998, Pub. L. No. 105-304, 112 Stat. 2860.

[290] Economic Espionage Act of 1996, Pub. L. No. 104-294, 110 Stat. 3488.

[291] Davis, *supra* note 31, at 407.

[292] Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting Firms in the U.S. Semiconductor Industry, 1979–1995*, 32 RAND J. ECON. 101, 108–09 (2001).

If the move towards more patenting continues—and if it is true that patents can entail certain transaction costs, reflect the cognitive bias of researchers, amplify fears about litigation, and block or suppress technological diffusion—then the trend towards stronger patent protection and the criminalization of patent infringement may inadvertently impede the distribution of clean energy technologies.

Some caveats must be advanced along with this conclusion, however. "[I]t is difficult to obtain a representative list of inventions and to determine whether each invention would have been developed or commercially introduced with or without patent protection."[293] While details related to changes in IPR and patenting exist, many aspects of the environment for innovation are changing at the same time, making it difficult to distinguish the effects of policy changes or patents from the effects of other contemporaneous developments.[294] Universities transfer knowledge through more than just patents, including the training of students, publication, faculty consulting, faculty involvement in new business enterprises, and a host of informal interactions.[295]

Nor are IPR reforms a substitute for a more robust and comprehensive energy policy. Numerous barriers extending beyond IPR continue to impede the diffusion of more efficient energy technologies. Atmospheric fluidized bed combustion (AFBC) systems, electrical generators that allow for the in-bed-capture of sulfur dioxide and reduce nitrogen oxide emissions, have been around since the mid-1960s, but are rarely used in the electric utility sector.[296] Generally higher capital costs compared to pulverized coal boilers, unfamiliarity with the technology, and the risk aversion and conservatism of utilities, rather than concerns related to IPR, have acted as significant impediments to their diffusion.[297] Variable and inconsistent policy incentives,

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[293] Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173, 173 (1986).

[294] *See generally* Adam B. Jaffe, *The U.S. Patent System in Transition: Policy Innovation and the Innovation Process*, 29 RES. POL'Y 531, 533 (2000) (discussing concurrent changes in the U.S. patent system, the international patent system, federal R&D funding, and other areas, and the effects of these changes on current policy issues).

[295] Mowery & Ziedonis, *supra* note 76, at 215.

[296] Santiago Bañales-López & Vicki Norberg-Bohm, *Public Policy for Energy Technology Innovation: A Historical Analysis of Fluidized Bed Combustion Development in the USA*, 30 ENERGY POL'Y 1173, 1173–75 (2002).

[297] *See id.* at 1175–76.

difficulty in setting environmental and permitting standards, lingering utility monopoly rules, industry resistance to change, and public misunderstanding have all acted as substantial deterrents to the diffusion of wind turbines and solar panels.[298] Simply targeting IPR barriers to clean energy technologies may be necessary, but insufficient to guarantee their deployment.

Nonetheless, a substantial and growing body of evidence suggests that the relationship between IP, IPR, and innovation is far from linear, predictable, or unproblematic. Strong patents may induce innovation and disclosure, but in other cases prevent, complicate, or delay commercialization. The restructuring of the electric utility industry has created further incentives against cooperative R&D. Small and large energy firms alike may be less willing to participate in collaborative agreements or patent pools since such acts could be viewed as undermining the financial gains to be made from exclusivity. A lack of substitutes for many energy technologies (from materials to fuel conversion processes) means some firms simply cannot invent around patents.

For these reasons, IPR issues will likely remain at the center of discussions concerning the innovation, development, and diffusion of clean energy technologies. Policymakers can continue to respond in an ad hoc manner, do nothing, or take prudent, sustained action to enhance innovation in the energy sector. Lawmakers can respond proactively now, or haphazardly later, when forced to by future events.

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[298] *See* Hirsh & Sovacool, *supra* note 5, at 81.

APPENDIX A: LIST OF EXPERTS INTERVIEWED[299]

First Name	Last Name	Organization Name	Area Of Expertise
Technical Experts			
Doug	Arent	National Renewable Energy Laboratory	Biofuels
Roger	Reisert	C2 Biofuels	Biofuels
Jeff	Harris	Alliance to Save Energy	Buildings Efficiency
Sue	Coakley	Northeast Energy Efficiency Alliance	Buildings Efficiency
Susan	Hovarka	Bureau of Economic Geology - Texas	Carbon Capture and Storage
Richard	Brent	Solar Turbines (VP)	Distributed Generation
Richard	Schmalensee	Massachussetts Institute of Technology	Economics and Management
Lee	Lane	Climate Policy Center	Economics and Management
Richard	Newell	Resources for the Future	Energy Efficiency
Brian	Murray	Nicholson Institute (Duke University)	Forestry and Agriculture
Neil	Elliott	American Council for an Energy Efficient Economy (ACEEE)	Industrial Efficiency
Sergio	Dias	Northwest Energy Efficiency Alliance	Industrial Efficiency
Jim	Rushton	Oak Ridge National Laboratory	Nuclear
Paul	Gunning	Environmental Protection Agency (EPA)	Other Gases
Dina	Kruger	Environmental Protection Agency (EPA)	Other Gases
Sally	Rand	Environmental Protection Agency (EPA)	Other Gases
Ajeet	Rohatgi	Georgia Institute of Technology	Solar PV
David	Greene	Oak Ridge National Laboratory	Transportation Efficiency
Robert	Thresher	National Renewable Energy Laboratory	Wind
Edgar	DeMeo	Renewable Energy Consulting Services	Wind
Paul	Gottleib	U.S. Department of Energy	Intellectual Property
Toni	Marechaux	Strategic Analysis Inc.	Intellectual Property
Robert	Devault	Oak Ridge National Laboratory	CHP Systems

[299] These interviews were conducted by one or, in most cases, two of the following individuals: Marilyn Brown, Sharon (Jess) Chandler, and the author. These interviews were conducted in conjunction with the preparation of a report for the U.S. Department of Energy: MARILYN A. BROWN, JESS CHANDLER, MELISSA V. LAPSA & BENJAMIN K. SOVACOOL, CARBON LOCK-IN: BARRIERS TO DEPLOYING CLIMATE CHANGE MITIGATION TECHNOLOGIES 70 (2007), *available at* http://www.ornl.gov/sci/eere/PDFs/ORNLTM-2007-124_rev200801.pdf.