The Circle of Power in LED Lighting

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I. Introduction

Light emitting diodes (LEDs) are a promising source of illumination for the future in terms of energy efficiency and architectural creativity, and are just beginning to penetrate the $40 to $100 billion estimated illumination market in the U.S.[1] In the U.S. in 2007, LEDs constituted only 0.01% of lumen-hours, as compared to 57% from fluorescents, 31% from high intensity discharge lamps, and 11% from incandescent lights.[2] Rapid technological progress, however, makes it likely that LEDs will surpass other light sources in terms of efficiency and cost-effectiveness in the coming years. Haitz's Law, depicted in Figure 1, highlights the 20 fold per decade increase in efficiency and the 10 fold per decade decrease in cost with LEDs.[3] Among other applications, LED lighting will be beneficial in applications where constant illumination is needed, such as in refrigeration case lighting in grocery stores, street lights, retail display, and down-lighting.

Figure 1. Haitz's Law Depicting Rapid Progress in LED Lighting

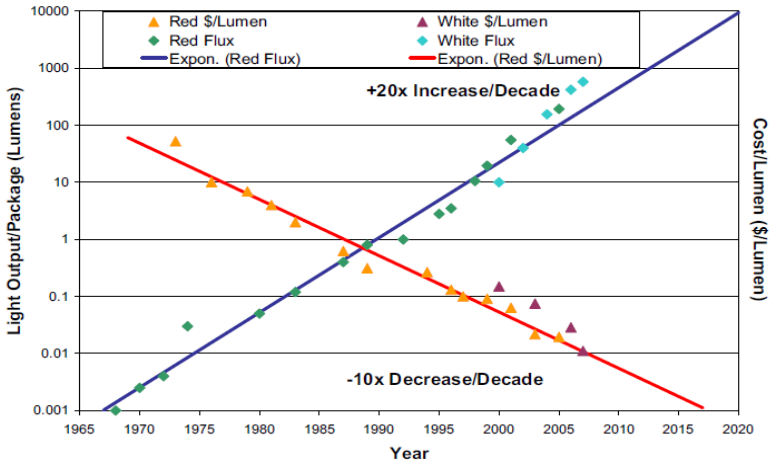


Figure 2-4: Haitz's Law: LED Light Output Increasing / Cost Decreasing
Source: Roland Haitz and Lumileds.
Note: Both lines are on the same numerical scale (with different units)

Despite the rapid progress with LEDs, barriers must still be overcome. In addition to the technical barriers, it is possible that patents in the LED industry may serve as a barrier to LED technology. Much attention is given to intellectual property in the LED industry. LED trade conferences have workshops on intellectual property, and industry publications devote sections of their websites to discussing patent issues.[4] Simons studies the patent landscape in LED lighting, but does so with the goal of predicting who the major players will be and how LEDs can be used to address global warming. He

[1] Sanderson, S. et. al., "Lighting Industry: Structure and Technology in the Transition to Solid State," version April 8, 2008, *available at* http://ssrn.com/abstract=1123500 (April 2008).
[2] Ibid.
[3] "Multi-Year Program Plan FY'09-FY'14 Solid-State Lighting Research and Development," Prepared for U.S. Department of Energy (March 2008).
[4] "Navigating the Intellectual Property Minefield," Strategies in Light Conference, Santa Clara, CA (February 2009); LEDs Magazine Patents and Licensing news, *available at* http://www.ledsmagazine.com/Patents, last visited March 15, 2009.

does not explicitly identify or resolve problems stemming from patents in LED technology.[5] Others speak on patents in LED lighting, but have not done formal analyses.[6] Therefore, players in the LED industry are left understanding that patents are important, but lack an understanding of whether problems exist, how to define those problems, or how to address them.

This paper seeks to fill this gap by explicitly identifying patent problems in LEDs and proposing solutions to these problems to promote innovation and growth in LEDs in the U.S. The conclusion is that the patent landscape overall in the LED industry looks healthy, but that industry players each perceive a unique set of problems that could lead to suboptimal innovation or dissemination of LEDs. First, small businesses wishing to compete upstream struggle due to the domination large companies have over patent rights. Actions that would aid small businesses include forming a patent pool, performing a freedom to operate analysis, increasing R&D funding to small businesses, or challenging patents for obviousness in reexamination. Second, downstream manufacturers may be confused by the patent landscape, unsure about which companies are safe to buy from and which will result in infringement. Confusion could be mitigated by including a patent roadmap laying out IP-safe and IP-unsafe components in the *Design Guidance* component of the DOE's 5-Year SSL Commercialization Support Plan. Third, large companies contend that they are losing revenues as a result of overseas producers making components in China or Southeast Asia and selling the products in the U.S. Large companies are already pursuing the most viable route of pursuing legal remedies at the International Trade Commission.

This paper will proceed as follows. Section II explains the basics of patent law, and identifies potential problems that could exist. Section III analyzes the patent landscape in LEDs overall, and then examines the patent landscape from the perspective of industry players including small businesses, downstream manufacturers, and large companies. Section IV proposes solutions for each identified problems. Finally, Section V concludes by proposing a way forward.

II. Patents and Patent Problems

A. Overview of the Patent System

A patent allows an inventor to exclude others from practicing the invention for a period of twenty years.[7] To receive a United States patent, the inventor must prove to the United States Patent and Trademark Office that an invention is novel, non-obvious, useful.[8] Novel means that the invention must not have been invented before, non-obvious that the invention must be more than an obvious variation from previous inventions, and useful that it must have some value. Additionally, the patent itself must teach others about the invention well enough to enable others in the field to practice the

[5] Sanderson, S. et. al., "Lighting Industry: Structure and Technology in the Transition to Solid State," version April 8, 2008, *available at* http://ssrn.com/abstract=1123500 (April 2008).
[6] E.g. Walker, Robert, "Navigating the Intellectual Property Minefield," Strategies in Light Conference, Santa Clara, CA (February 2009).
[7] 35 U.S.C. § 102 to §154.
[8] 35 U.S.C. § 102 to §103

invention.[9] Patents are territorial, meaning and inventor must receive a patent in every country in which he wishes to have protection.[10] A product that is patented in the U.S. but not in China can be made and sold in China without infringing the U.S. patent, but would infringe if made in China and then sold in the U.S.

The purpose of the patent system is threefold. First, it encourages innovation by granting a twenty year monopoly over the invention, allowing the inventor to reap higher than average profits from the invention.[11] The above-normal profits give companies incentive to invest more in R&D. Second, where significant costs are involved not only in R&D, but also in scaling up production of the invention, the exclusion rights give a patentee incentive to invest in scaling up.[12] Finally, patents serve a teaching function by being published and open to the public. Others can learn from patents, theoretically increasing the dissemination of knowledge and speed of innovation.[13]

An entity will infringe a patent by making, using, selling, or offering to sell the patented invention without consent from the patent owner. Two points are important to highlight here. First, "using" includes using a patented invention for research.[14] A current example of this is with stem cell patents. Academics and researchers argue that patents inhibit progress with stem cells because scientists cannot conduct research using the core patented tools for stem cells without consent from patent owners. Second, infringement can be direct use of the invention, or indirect use. Indirect infringement includes, for example, selling a component in China when the seller knows that the component will ultimately be used in the U.S., where it is patented. Here the Chinese seller induces the buyer to infringe.[15] The company using the component in the U.S. would be the direct infringer and the company that made and sold the component in China would be an indirect infringer.

B. Potential Patent Problems

Despite the good intentions of the patent system, negative consequences can result. Three negative consequences that may result from the patent system are relevant to this analysis:

1) **Insufficient innovation** due to a lack of investment in R&D, thus slowing the technological progress of LEDs. This could result from potential entrants being unable to enter the industry because they are shut out by patent owners, or from large companies under-investing in R&D because they have trouble enforcing patent rights against infringers.

[9] 35 U.S.C. § 100 to §101.

[10] *See, e.g.,* Holbrook, T., "Extraterritoriality in U.S. Patent Law," William and Mary Law Review, vol. 49 (May 2008).

[11] Lemley, M. "Rethinking Patent Law's Resumption of Validity," 60 Stan. Law Rev. 45 (October 2007).

[12] Ibid.

[13] Ibid.

[14] *See, e.g.*, Lee, P., Inverting the Logic of Scientific Discovery: Applying Common Law Patentable Subject Matter Doctrine to Constrain Patents on Biotechnology Research Tools," Harvard Journal of Law and Technology, vol. 19 (Fall 2005).

[15] 35 U.S.C. § 271; see, e.g., Adams, C., "A Brief History of Indirect Liability for Patent Infringement," Santa Clara Computer and High Technology Law Journal, vol. 22 (March 2006).

2) **Adoption and dissemination of LEDs is constrained** by patents once technical barriers are overcome. This may result from too many patents causing confusing and diffuse ownership rights, from obvious patents covering core technology, or from excessively high prices resulting from monopolies or anticompetitive behavior.
3) **Excessive resources spent** on patent litigation.

This paper will investigate and refer back to these potential problems when discussing whether patent problems exist in the LED industry.

III. Patent Problems May Inhibit Innovation or Dissemination

A. No Problems from Perspective of LED Patents Overall

A first way to analyze whether a problem exists is by examining the LED patent landscape as a whole, and comparing LED patent trends to other industries. This analysis could highlight problems in innovation, adoption and dissemination of technology, or excessive spending on patent litigation. This section will show that innovation, dissemination, and litigation spending in LEDs all look healthy from the overall LED patent perspective.

The number of patents in a field is often used as a measure of innovation.[16] This is because the number of patents is typically correlated with the amount of R&D investment, and the amount of R&D is thought to reflect the level of innovation. If we spend more on R&D, we expect to see more patents and more innovation, and vice versa. Figure 2 below shows the increasing number of patents overall in the U.S. with the total R&D spending.[17] In contrast, Figure 3 shows the decreasing spending on R&D in the energy sector and the corresponding decrease in patents.

Figure 2. Number of U.S. Patents and R&D Funding

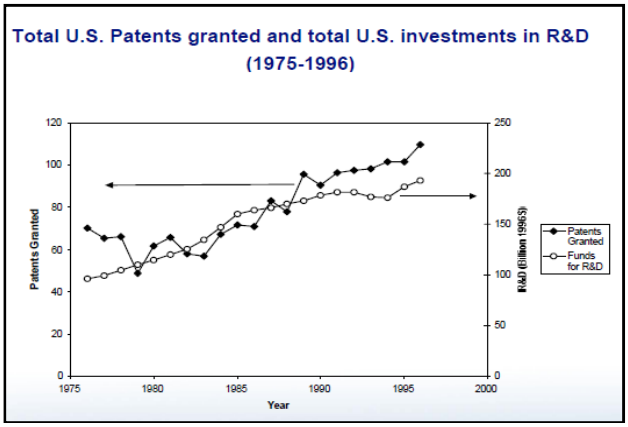
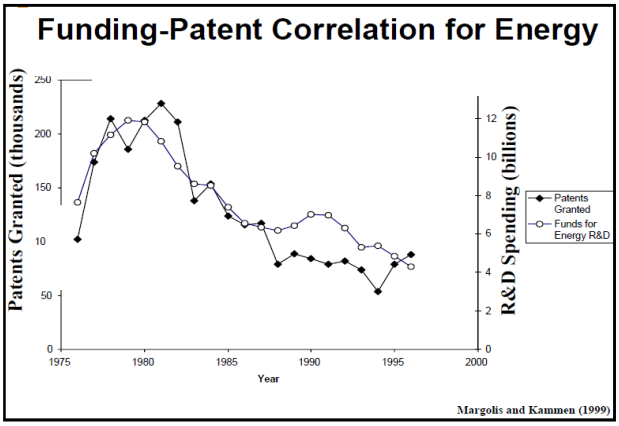


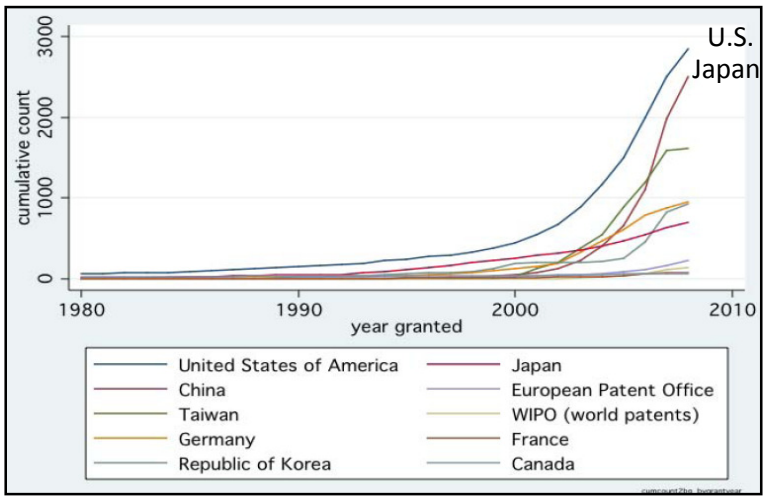
Figure 3. Number of U.S. Energy Patents and R&D Funding



[16] Margolis, R. and D. Kammen, "Underinvestment: The Energy Technology and R&D Policy Challenge," *Science* 30 Vol. 285. p. 690 (July 1999).
[17] Ibid.

Figure 4 below shows the growth in LED patents in several countries.[18] The top curve in blue represents growth in U.S. LED patents, and is more exponential than linear, representing a good deal of growth. LEDs have followed a more positive trend than the rest of the energy industry, indicating sufficient investment in R&D and therefore healthy innovation.

Figure 4. Cumulative Patent Grants in the U.S. and other countries[19]



Although the number of patents is used as an indicator of innovation, an excessive number of patents may pose a problem in that they would lead to what is called a "patent thicket."[20] This happens with complex technologies when too many patents each cover a small section of an invention, and cause ownership rights to be spread amongst too many players. The consequence would be insufficient adoption and dissemination of technology because companies wishing to make the final complex product must sort through a mess of patents to figure out who owns what, and must negotiate a license with a large number of companies. An example of this is in the nanotechnology industry where 3700 patents were issued from 2001 to 2003.[21] Although no exact numbers exist for when many patents is *too* many patents, LEDs have several hundred patents be issued annually, which is less than the several thousand which are the quantities written about in patent thicket situations.[22] If LEDs continue with such rapid progress, however, it is possible that LEDs will become an industry where excess patents are a problem as technology develops.

Finally, we can compare the litigation patterns among LED patents to other patents to gauge whether patents are consuming abnormally high resources. The average cost of litigation where between $1 million and $25 million are at stake is $2.5 million per side.[23] Adding to this the time and

[18] Simons, K. and S. Sanderson, "SSL Technology Development and Commercialization in the Global Context," *available at* http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/simons_ssl09.pdf, last visited 3/4/09 (2009).
[19] Simons and Sanderson (2009).
[20] Lemley, M. and C. Shapiro, "Patent Holdup and Royalty Stacking," Texas Law Review, vol. 85 (2007).
[21] Lemley, M, "Patenting Nanotechnology," Stanford Law Review, vol. 58 (November 2005).
[22] *See, e.g.*, Lemley and Shapiro (2007).
[23] AIPLA Report of the Economic Survey 2007.

energy required for litigation, excessive litigation can drain a company of resources. Approximately 1.1% of LED patents are litigated,[24] compared with around 1.5% of patents overall.[25] This means that although much attention has been given to litigation battles, litigation rates are below average patent litigation rates. This section thus concludes that looking at the LED patent landscape overall does not indicate the existence of problems in innovation, dissemination, or resource spending on patents.

B. Industry Players Perceive Distinctive Problems

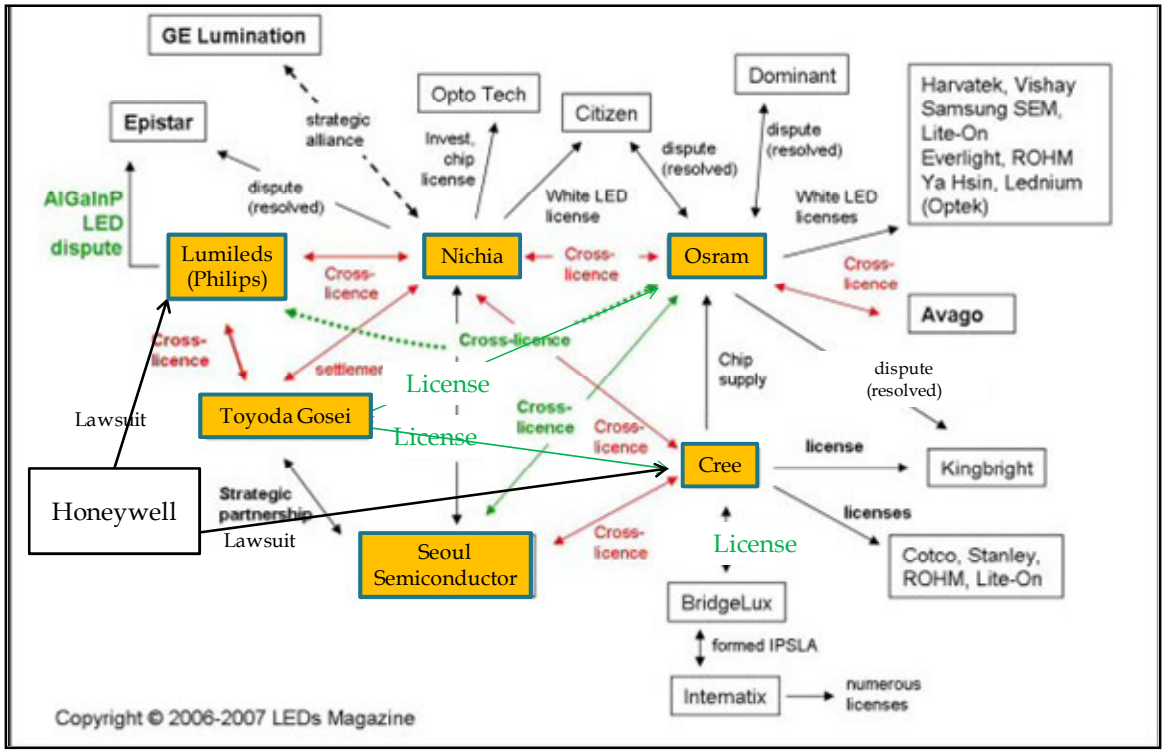
Although the overall LED patent landscape looks healthy, industry players do still perceive problems which may signal lost opportunity in terms of innovation or dissemination of LEDs. This section first describes the history and current allocation of patents and patent licenses in the LED industry. It then investigates potential problems from the perspective of small businesses, downstream manufacturers and distributors, and large companies.

1. LED Patents are Controlled by Six Companies

Patents in the LED industry are largely owned and cross-licensed between six large companies: Nichia and Toyoda Gosei in Japan, Philips in the Netherlands, Osram in Germany, Cree in the United States, and Seoul Semiconductor in South Korea.[26] Intense litigation has occurred between many of these companies, beginning with Nichia suing Toyoda Gosei in 2000 over the core technology for blue LEDs. Between 2000 and 2008, around 30 lawsuits relating to LEDs had been filed, with many of the six companies above bringing lawsuits against each other.[27] For example, Nichia sued Cree later in 2000, Osram sued Nichia in 2001, and Nichia and Seoul Semiconductor counter-sued each other in 2007.[28] By late 2008 or early 2009, much of the litigation settled, ending in cross-licenses almost across the board among the above six companies. The current landscape consists of significant cross-licensing between these six companies, and all others outside this circle must license from these companies to have any hope of participating in the industry. Figure 5 illustrates the complexity of patent licensing in LEDs, and shows the six companies mentioned above highlighted in orange as being cross-licensed with each other and controlling access to patents.

[24] Analysis done for this paper using the Stanford Intellectual Property Litigation Clearinghouse. The number of lawsuits involving LED lighting totaled 30, and this was compared to the overall count of about 2800 LED patents.
[25] Levko, A. et. al., Price Waterhouse Coopers, "A Closer Look: 2008 Patent Litigation Study: Damages Awards, Success Rates and Time-to-Trial," (2008).
[26] Many sources do not list Seoul Semiconductor as a major player, but the company plays a large enough role in patent disputes to justify inclusion in this paper.
[27] Research conducted for this paper using the Stanford Intellectual Property Litigation Clearinghouse.
[28] Ibid.

Figure 5. Six Patent Holding Companies and Licensing Agreements[29]



An additional point on the control of patents is that because patents are territorial, different companies may own patents covering similar technologies in different countries. A divide is thought to exist. On one hand, the U.S., Europe and Japan are generally thought to enforce patent rights and companies in these countries are thought to respect patent rights. On the other hand, China and Southeast Asian countries are thought to enforce patents less and companies in these countries are thought to operate without much attention to patent rights.[30] The result is that producers in China and Southeast Asia produce and sell legally in their own countries, and also export to the U.S., Europe, and Japan illegally. This tension and occasional illegal importation has significant consequences for patent holders in the U.S., Europe, and Japan.

Equipped with an understanding the allocation of patents, we now turn to the impact this has on industry participants.

2. Small Businesses are Shut Out

The concentration of patents in a few large companies prevents small companies from entering the field as freely as they would like, which may lead to suboptimal innovation as small companies are often responsible for significant advances.[31] A first difficulty is that small companies lack bargaining

[29] Figure adapted from LEDs Magazine, *available at* http://www.ledsmagazine.com/Patents. Updated and modified for this paper February 9, 2009 to include Honeywell, and additional lawsuits and licenses.
[30] Walker, Robert, Presentation at "Navigating the Intellectual Property Minefield," Strategies in Light Conference (February 2009).
[31] Christensen, Clayton, The Innovator's Dilemma, p. 149, HarperBusiness, New York, NY (2000).

power to negotiate a reasonable license from patent holders, unless the small company itself has a significant invention. It is thought that the patent holding companies try to squash potential competition by being uncooperative in licensing. This sentiment was expressed by Robert Walker, the former CEO of Bridgelux, one of the few new companies to succeed in entering the market.[32] A second concern is that at least some venture capitalists are reluctant or hesitant to invest in early stage LED-focused companies.[33] They feel like small entrants have little chance of succeeding unless the company has a groundbreaking and patented technology that can be used for bargaining power. Finally, some contend that some patents held by the major LED players are obvious, meaning they should never have been granted. If obvious patents cover core technologies, innovation will be slowed. In sum, problems exist from the perspective of small companies that may inhibit innovation.

3. Downstream Manufacturers & Distributors are Uncertain

Downstream manufacturers, such as Sharp, do not compete head to head in the core technologies that the six patent-holding companies are fighting so hard to protect. But, they do need to buy and use legitimate components in their products to avoid being sued for infringement. The sentiment expressed by downstream competitors is that they are confused about what components are safe, and which would result in infringement.[34] Larger and presumably sophisticated companies, such as Sharp, may intentionally take a chance and disregard patent rights in hopes that a patent may be found invalid or that no action will be taken. Smaller downstream players, however, may legitimately have difficulty navigating the patent landscape and understanding which components are legal and which may result in a lawsuit. If downstream players fear being sued, they may hold back in output and distribution, leading to constrained adoption and dissemination of LEDs.

4. Large Company See Under-Enforcement for Overseas Infringers

Finally, large companies that hold the majority of patents are content with the patent distribution in the U.S., Europe, and Japan. They believe there is plenty of competition and innovation. For example, George Craford, the Chief Technology Officer at Philips Lumileds, in an interview stated that he believes patent issues have worked themselves out, with larger companies licensing to smaller ones.[35] Companies like Philips have invested significantly in building up or buying a strong LED patent portfolio and should reap the benefits of this investment. Philips, for example, bought Color Kinetics in 2007 for nearly $800 million in large part for Color Kinetics' patent portfolio.[36]

The concern of large companies, however, is in retaining and growing market share in light of overseas competition.[37] They contend that overseas producers in China and Southeast Asia are making infringing products, and then selling them to downstream players such as Sharp in the U.S., Europe, and

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[32] Walker, Robert, Interview at "Navigating the Intellectual Property Minefield," Strategies in Light Conference (February 2009).
[33] Ibid.
[34] Discussion at "Navigating the Intellectual Property Minefield," Strategies in Light Conference (February 2009).
[35] Craford, George, CTO of Philips Lumileds, phone interview held February 10, 2009.
[36] "Philips to buy Color Kinetics in $791 million deal," LEDs Magazine, *available at* http://www.ledsmagazine.com/features/4/8/9, last visited March 14, 2009 (August 2007).
[37] News Release from Nichia, *available at* http://www.nichia.com/about_nichia/2005/2005_011801.html, last visited March 14, 2009; George Craford interview February 10, 2009.

Japan. For example, Epistar, based in Taiwan, was sued by Philips for patent infringement in 2007. The desire of patent holders to protect their territory makes sense given that the current market for LEDs is fairly small when compared to the size and number of companies involved in the industry. The LED market worldwide is estimated to be $4.7 billion,[38] and must be spread not only among the six major patent holders such as Philips, which has $26 billion in revenue annually, but also among the downstream players and overseas manufacturers.[39] Additionally, these large players are likely even more concerned as a result of their dwindling market shares in traditional lighting, as overseas producers have largely taken over the traditional lighting market.[40]

IV. Proposed Solutions

A. Assist Small Companies Compete Upstream

Several options could assist smaller companies wanting to participate in the upstream LED market. A first option is to create a patent pool that would bring together the patents of several companies and make those patents licensable to any company wishing to enter the industry.[41] A patent pool can be beneficial with complex technologies where several companies own key patents, as is the case with LEDs. The benefit of a patent pool is that it allows anyone to license provided that they can afford the fee. The risk of patents pools, however, is that patent holders may refuse to cooperate or may charge outrageous fees.[42] Some industries, such as the DVD industry, have taken this route rather successfully.[43] In order to succeed in LEDs, the participation of technology strategy leaders at the key patent holding companies, such as Philips, Osram, and Nichia, would be required. A leader in the DOE's Solid State Lighting team or a CTO within the industry could lead this effort. Notably, Philips has the most open licensing policy of the large companies, making its patents available to license from its website. Osram is also open to licensing.[44] If Kevin Dowling and or others at Philips or Osram could be convinced to lead this effort, it may become a viable strategy.

A second option to assist small companies wishing to participate in upstream R&D is to clearly identify those spaces in which it is safe to do research by conducting a "freedom to operate" analysis. In a freedom to operate analysis, a company identifies its desired research scope in terms of technology and geography.[45] An intellectual property lawyer then determines what parts of that research may be

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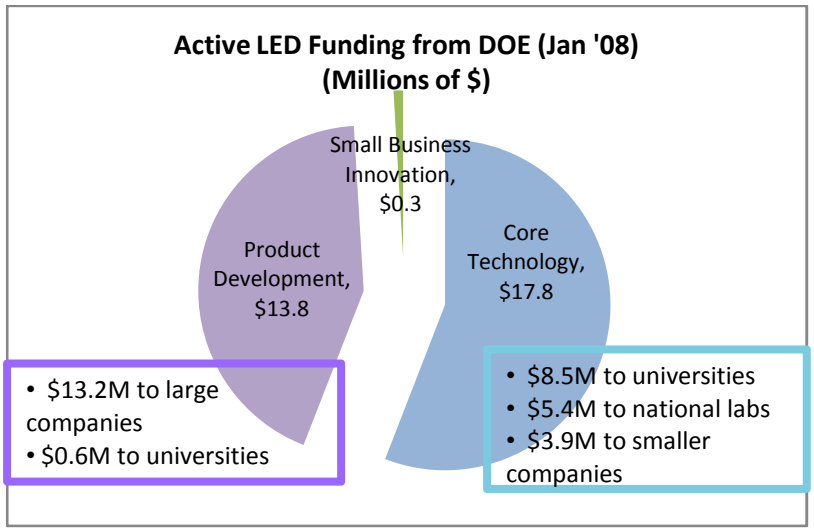
[38] Sanderson, S. et. al., "Lighting Industry: Structure and Technology in the Transition to Solid State," version April 8, 2008, *available at* http://ssrn.com/abstract=1123500 (April 2008).
[39] Philips, Annual Report 2008, *available at* http://www.philips.com/about/investor/financialresults/annualreports/index.page, last visited March 14, 2009.
[40] Sanderson, S. et. al., "Lighting Industry: Structure and Technology in the Transition to Solid State," version April 8, 2008, *available at* http://ssrn.com/abstract=1123500 (April 2008).
[41] Lemley, M. and C. Shapiro, "Patent Holdup and Royalty Stacking," Texas Law Review, vol. 85 (2007).
[42] Ibid.
[43] Hovencamp, H., et al. IP and Antitrust, Cross-Licensing and Patent Pools. Vol. 2, Chapt. 34. Aspen Publishers, United States (2009).
[44] http://www.ledsmagazine.com/news/5/9/31
[45] Frank, Steven, Presentation on "Navigating the Intellectual Property Minefield," Strategies in Light Conference (February 2009).

inhibited by patents, and what steps, such as licensing agreements, are necessary to avoid infringement. The end result is a written opinion by the lawyer of steps that a company should take to avoid infringement. This analysis typically costs around $15,000.[46] The benefit is that this is relatively inexpensive and can be done by an individual company. The downsides are that it is technology-specific, and the company is not protected if the lawyer was wrong in her opinion. It may be possible to leverage a freedom to operate analysis to assist more than just a single company. If an area of research is of interest to several small companies, the SSL committee of the DOE, or a group of companies, could combine resources to conduct an analysis and make the results available to several companies.

A third option for assisting small companies would be to dedicate more funding to small companies wanting to participate in core technology research. A breakdown of LED R&D funding from the DOE, shown in Figure 6, indicates that only $3.9 million out of nearly $32 million goes to small companies.[47] Reallocation of funding may be difficult as it would require convincing the panel that allocates grant money, which is likely comprised at least partly of participants from universities and large companies.

Figure 6. DOE Funding Allocations



A final option that would assist small companies in entering the market is to challenge the validity of blocking patents. Two recent legal changes make this a viable option. First, a recent United States Supreme Court decision called KSR sets a more lenient standard for finding obviousness, meaning that a company challenging a patent's validity would be more likely to win.[48] The second recent change is the availability of a new process to challenge patent validity. The traditional method of challenging

[46] Ibid.
[47] Department of Energy, Current Light Emitting Diode Projects, *available at* http://www1.eere.energy.gov/buildings/ssl/projects.html#2008portfolio, last visited March 5, 2009. Note that these numbers include only DOE funding for Inorganic LEDs, and not funding provided by companies to assist in these projects or funding for Organic LEDs.
[48] See, e.g., Joike, T. et. al., "It is not so obvious: The Impact of KSR on Patent Prosecution, Licensing, and Litigation," American Intellectual Property Law Association Quarterly Journal, vol. 36 (Summer 2008).

patents is through litigation in court, but a less costly procedure called ex-parte re-examination may be a better option for smaller companies. Re-examination allows a patent to be challenged in front of the United States Patent and Trademark Office instead of going to court. This process costs about $20,000 as opposed to $2.5 million, and has a high success rate according to preliminary findings.[49] This process is risky, however, in that once a party challenges a patent through re-examination that party can no longer make the same challenges in court. Additionally, challenging a patent in re-examination may draw attention to smaller companies as being potential infringers.

A point to keep in mind is that if important patents are expiring, maybe no action is needed. Steven Frank, an attorney who has spoken on LED patents at the Strategies in Light Conference for the past two years, believes that patents covering core upstream technology are expiring and newer patents cover more application-specific inventions.[50] If true, this would decrease blockage as patents would apply to only narrower group of applications and would be easier to design around.

B. Clarify for Downstream Manufacturers & Distributors

The best way to help downstream manufacturers would be to construct a patent roadmap, or a set of recommended steps a manufacturer would need to take to make a product while avoiding patent infringement.[51] This is similar to the freedom to operate analysis discussed above, and requires the assistance of an intellectual property lawyer. A company would hire a lawyer, and then identify with the lawyer the technical components of the product it wishes to make. The lawyer then conducts an intellectual property search to determine what components and processes may be used without a license and which require a license. The final product is a written recommendation of the steps needed to make the desired product while avoiding infringement. If a product is of interest to many manufacturers or distributors, an analysis could be integrated with the DOE's 5-Year SSL Commercialization Support Plan. This plan includes publishing Design Guidance material that helps downstream players buy components. A way forward would involve working with manufacturers and members of the DOE who contribute to the Design Guidance publication to identify critical areas of technology and include patent information if helpful.

C. Enforce Infringement from Importation for Large Patent Holders

The most straight-forward way for patent holders to address concerns about overseas infringers is to first attempt to negotiate, and then to enforce patent rights at the International Trade Commission (ITC) to stop importation. The ITC is a separate court from normal U.S. courts in that it deals only with international trade issues for products being shipped to the U.S., and its only power is to stop the importation of any products it finds to be infringing. This is in contrast to regular U.S. courts which can stop others from infringing, and give monetary rewards for past infringement. The ITC process is quick, taking a few months as opposed to a few years. Companies such as Philips are pursuing this route, and

[49] Frank, Steven, presentation at "Navigating the Intellectual Property Minefield" presentation, Strategies in Light Conference (February 2009).
[50] Frank, Steven, interview conducted at the Strategies in Light Conference February 18, 2009.
[51] Frank, Steven, presentation at "Navigating the Intellectual Property Minefield" presentation, Strategies in Light Conference (February 2009).

should continue to do so.[52] As the ITC is separate from U.S. district courts, companies will often bring suit in both courts to increase chances of winning.

V. Conclusion

This analysis has shown that patents may introduce problems that inhibit innovation or dissemination of LEDs. The table below summarizes proposed ways forward, necessary participants, and ways to mitigate the risks associated with each recommendation.

Recommendation	Participants	Mitigating Risks
Form a patent pool	Large company patent holders, DOE SSL leader	Ask Philips or other large player to lead to increase chance of participation
Increase small company funding	DOE Funding Decision Committee	Seek alternative source of funding so other players do not see cuts
Challenge patents in re-examination	Companies (e.g. Bridgelux)	Test abroad, Pick only the most likely obvious patents
Freedom to operate analysis for research	Small R&D companies or facilitation by DOE	Survey companies at DOE conference to see if helpful
Patent roadmap for manufacturers & distributors	Manufacturer/Distributor or facilitation by DOE	Survey companies at DOE conference to see if helpful
Enforce patents against overseas infringers in ITC	Large company patent holders	Also litigate in district court for two chances to win

The above steps can be taken to alleviate immediately observable pains. As LED lighting is still in its infancy in terms of market penetration, however, the patent landscape may change significantly in the coming years. As the industry grows and large companies are able to bring in significant revenue from LEDs, patent holding companies may become more open to creative relationships and thus ease the patent situation. Alternatively, however, patent holding companies may become even more assertive in positioning themselves to benefit from the growing market. This may increase litigation and cause an explosion in patents as companies try to build a negotiating arsenal. If this does result, a way to aggregate patents such as through a patent pool will become even more important as the landscape will be even more complex. As it is unclear what will happen, maintaining good communication between industry players and the DOE may be the most critical component to achieving the best result for whichever scenario does occur.

[52] Philips News Release, "U.S. Customs to begin blocking importation of LED products that infringe Philips Lumileds' Patent Rights," *available at* http://www.philipslumileds.com/newsandevents/releases/PR79.pdf, last visited March 14, 2009.