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Patent Trends in the Cleantech Industry

By Todd R. Miller, James W. Peterson, and T. Christopher Tsang

From the Energy Independence and Security Act of 2007 to the unparalleled $2.4 billion that investors poured into energy tech startups in 2006, the actions of both government and the private sector reflect the renaissance shining brightly in the area of clean technology.[1] The growth in this technology is aided by a convergence of advances in material sciences, biology, and information technology, and its eager adoption by traditional industries. Innovation abounds, with the number of patents and patent applications on the rise during the past decade. A great many of these intellectual property rights are in the hands of many, including individuals. This observation may explain why there has been so little litigation to date. As cleantech becomes more established in the strategies of mature companies, expect more patents to belong to fewer and litigation to rise accordingly.

Prosecution Trends

Cleantech, unlike nanotechnology and many other technologies, does not have an assigned class at the US Patent and Trademark Office (PTO) or in any other country's patent offices.[2] Moreover, cleantech applications often involve a number of disciplines. Thus, two cleantech patents may fall within different classes, with each being assigned multiple subclasses. The result is that there is no way to easily and broadly search databases for cleantech patents or patent applications.

There are a number of approaches to generating statistics about cleantech patents. One approach is the shotgun approach in which a class, such as class 060 "power plants," is searched, resulting in many possible patents or applications that may fall within cleantech. Another approach is to select specific subclasses in a class, such as class 060 "power plants" and subclass 641.1 "utilizing natural heat," that identify a much smaller number of patents or applications to review, yet leave out many that qualify as cleantech. Or a word search, such as "solar," can be employed, also retrieving many possible patents or applications. Of course, some combination of the above approaches can be used, such as a word search in which the possibilities are filtered by relevant classes and subclasses.

Compounding the complexity is the fact that cleantech represents in many cases improvement in certain aspects of existing technology and thus shares the same classification. The International Energy Agency (IEA) has characterized cleantech in terms of generation.[3] First-generation technologies originated from the industrial revolution at the end of the 19th century and are in widespread use. These include hydropower, biomass combustion, and geothermal power and heating. Second-generation technologies, such as solar heating and cooling, photovoltaics, and wind power, are now entering markets as a result of research and development triggered by the oil crises of the 1970s. Third-generation technologies are not yet widely commercialized but

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incorporate many of the current scientific and engineering advances, including advanced gasification, biorefinery, concentrating solar thermal power, hot-dry-rock geothermal power, and ocean energy.

The data here focus on five segments of cleantech:

1. Renewable energy;
2. Biofuels/synfuels;
3. System integration;
4. Environmental and water; and
5. Transportation.

Renewable energy includes:

- Geothermal;
- Hydro;
- Solar;
- Solar thermal;
- Wave; and
- Wind.

Biofuels/synfuels includes:

- Biofuels;
- Biodiesel;
- Biomass; and
- Synfuels.

System integration includes:

- Water-energy synergy;
- Distributed generation/on-site power;
- Energy storage;
- Enabling transmission;
- Power systems simulation; and
- Smart grid.

Environmental and water includes:

- Water-energy conservation;
- Bioremediation;
- Desalination;
- Phytoremediation;
- Recycling;
- Smart fertilizers;
- Waste utilization;
- Water purification;
- Water treatment; and
- Air quality.

Transportation includes:

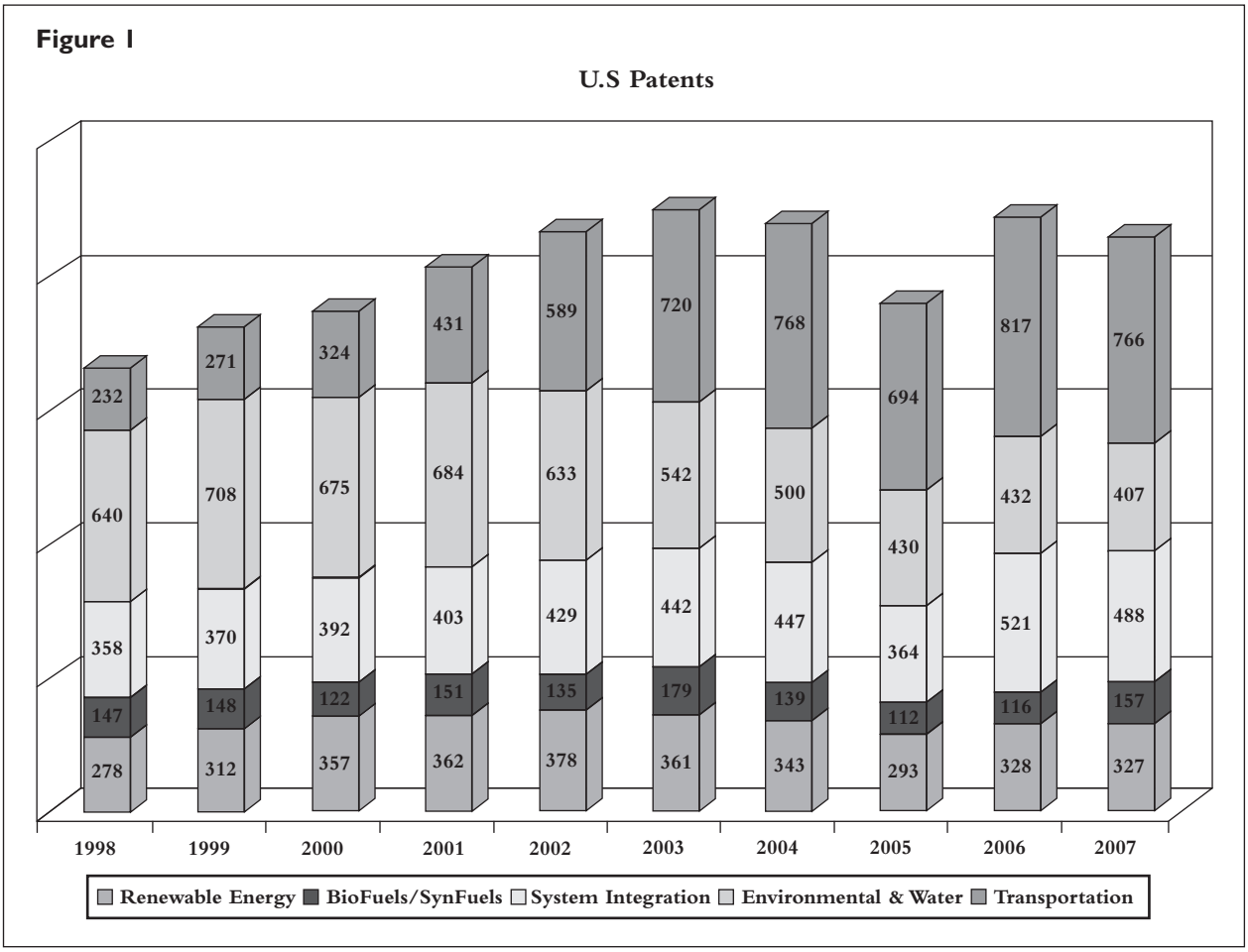
- Hybrid electric vehicles;
- Fuel cells;
- Hydrogen; and
- Zero emissions.

Within each segment, patent data have been obtained through word searching, and the data have been reviewed for relevancy. The relevant patent data are reported here; however, such data do not attempt to classify a single patent in any one segment in a case in which the patent is multidisciplinary and may fall within multiple segments. For this reason and those elaborated above, the data should be treated with caution and instead viewed as helpful to an understanding of cleantech patent activities.

United States Data

As seen in Figure 1, the overall number of cleantech patents that have issued in the United States over the past decade has steadily increased. Somewhat surprisingly, there is no noticeable increase in the number of patents issuing in the renewable energy and biofuels/synfuels segments. Instead, these segments show only a modest increase. The system integration segment shows a better increase, with a total of 358 possible patents issuing in 1998 to 488 in 2007. The best increase can

Figure 1



be seen in the transportation segment. In contrast, the environmental and water segment has noticeably decreased, going from 640 to 407 in a decade.

Importantly, no one entity seems dominant in patent numbers in any one segment. Indeed, in all but the transportation segment, the largest percentage of patents that issued did not identify an assignee. This observation suggests that a large percentage of patents belong to individuals.[4] Those that were assigned constitute a relatively small number of patents spread rather equally across the board.

Renewable Energy

Taking a closer look at the renewable energy segment over the past decade, 23.3 percent of the patents that issued were not assigned. This proportion is quite significant, particularly when one considers that the next-largest recipient of issued patents has only 1.4 percent.

The subject matter areas that continually show up in the renewable energy segment are:

- Prime-mover dynamo plants; fluid-current motors;
- Power plants; utilizing natural heat;
- Prime-mover dynamo plants;
- Tide and wave motors; and
- Power plants; pressure fluid source and motor.

Companies that show up in the searches consistently include: Canon Kabushiki Kaisha (solar and wave); The Boeing Company (solar); and Mitsubishi Denki Kabushiki Kaisha (solar). Other companies include: Ocean Power Technologies, Inc., and Murata Manufacturing Co., Ltd., both of which are involved in tide and wave applications; United Technologies Corporation (solar); Kalex, LLC (geothermal); Midwest Research Institute (wind); and Ambient Systems, Inc. (nanoscale electromagnetic system).

Biofuels/Synfuels

Over the past decade, 13.4 percent of the issued patents in the biofuels/synfuels segment did not identify

an assignee. The largest recipient of patents, Chevron U.S.A. Inc. (primarily synfuels), received a mere 1.0 percent. Other companies that have been active over the years include ExxonMobil Research and Engineering Company (primarily synfuels), Energy BioSystems Corp. (biofuels), The Lubrizol Corp. (synfuels), The Regents of the University of California (synfuels, some involving nanoparticles), BASF Aktiengesellschaft (biofuels), Institut Français du Pétrole (biomass), Metabolix, Inc. (biomass), and Midwest Research Institute (biomass).

System Integration

In the system integration segment over the past 10 years, some 13 percent of the patents did not identify an assignee. Prevalent companies in this segment include Motorola Inc., Hitachi, Ltd., Honeywell International, Inc., and Lockheed Martin Corp.

Environmental and Water

In the past 10 years, 26.5 percent of the patents in the environmental and water segment system did not identify an assignee. The largest recipient, Nalco Company, was assigned less than one percent of issued patents. Other companies in this segment include Access Business Group International LLC, Halliburton Energy Services, Inc., Sharp Kabushiki Kaisha, and United States Filter Corp.

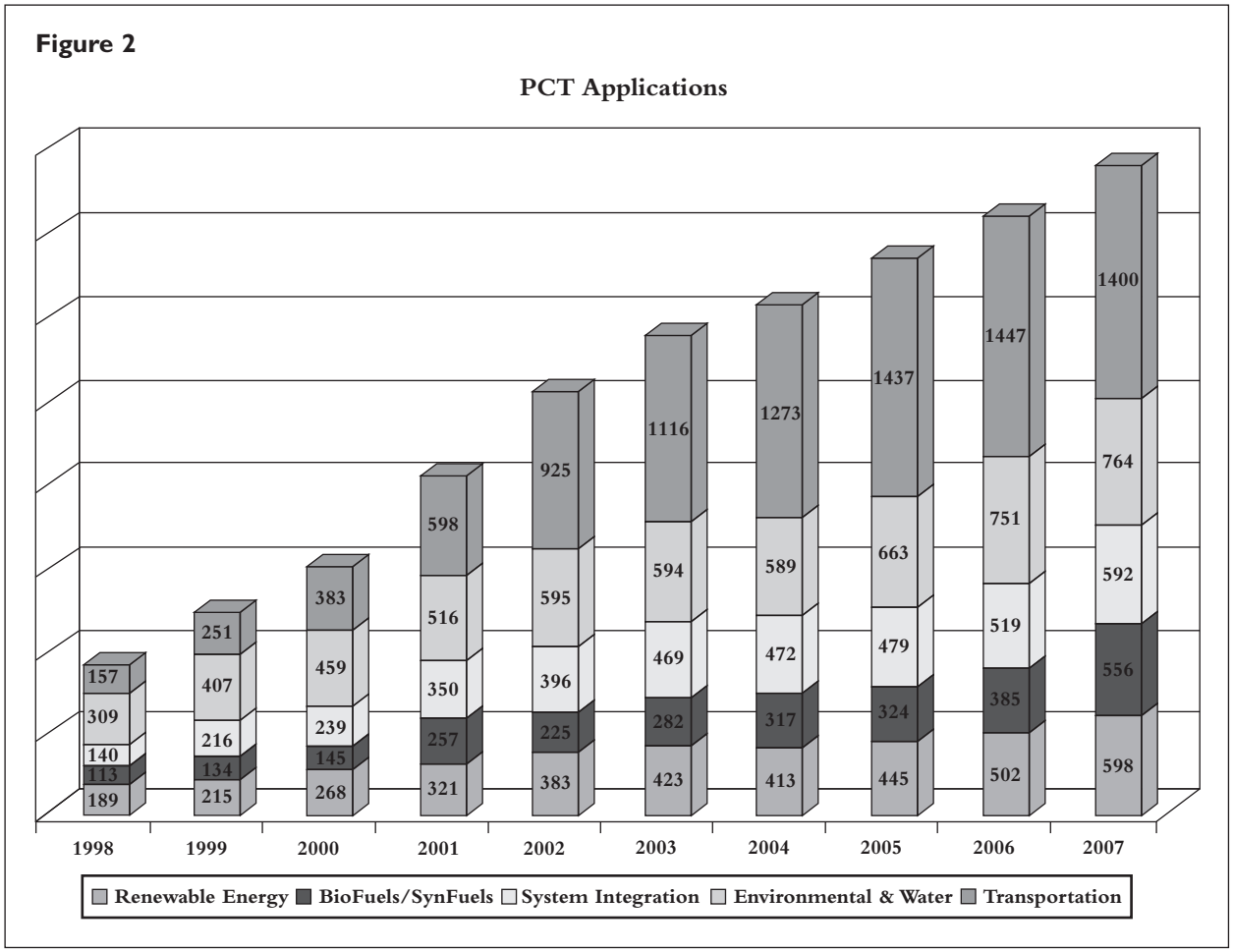
Transportation

The transportation segment, as to be expected, has its largest percentage of patents assigned to a corporate entity. Over the past decade, Honda Giken Kogyo Kabushiki Kaisha has been identified as an assignee 7 percent of the time, followed by General Motors Corp. (5 percent), Toyota Jidosha Kabushiki Kaisha (3.8 percent), Nissan Motor Co., Ltd. (2.8 percent), and UTC Fuel Cells, LLC (2.5 percent). Only 3.3 percent did not have an assignee identified. It should come as no surprise that fuel cells constitute the subject matter most frequently covered, with hybrid electric vehicles next in line.

Patent Cooperation Treaty Data

Over the past decade, the number of Patent Cooperation Treaty (PCT) applications has also increased steadily in the cleantech arena. Figure 2 shows this general trend.

Figure 2



Like the US data, the data shown here do not necessarily relegate a patent to only one segment when more than one applies. Moreover, an international application may be published more than once, that is, when it is published initially without a search report and then published again with one. The data shown in Figure 2 do not attempt to distinguish between the same application being published more than once, an occurrence that takes place perhaps 20-30 percent of the time. The data in Figure 2 helpfully illustrate the upward trend in PCT filings that has taken place—across the board in all segments—over the past decade. In this regard, the PCT data differ from the US data, showing a downward trend for the environmental and water segment.

Like the US data, the percentage of PCT applications without any identified assignee is the largest, with the exception of the transportation segment. Similarly, no one company is dominant in any one segment. The companies that have been assigned PCT applications basically mirror the same companies identified with regard to the US data for each segment, with the notable exception of the renewable energy segment. There, Aloys Wobben, chairman and managing director of Enercon GmbH (wind applications), is the number one assignee of PCT applications, with some 1.8 percent of the total.

The top applications in each segment are as follows:

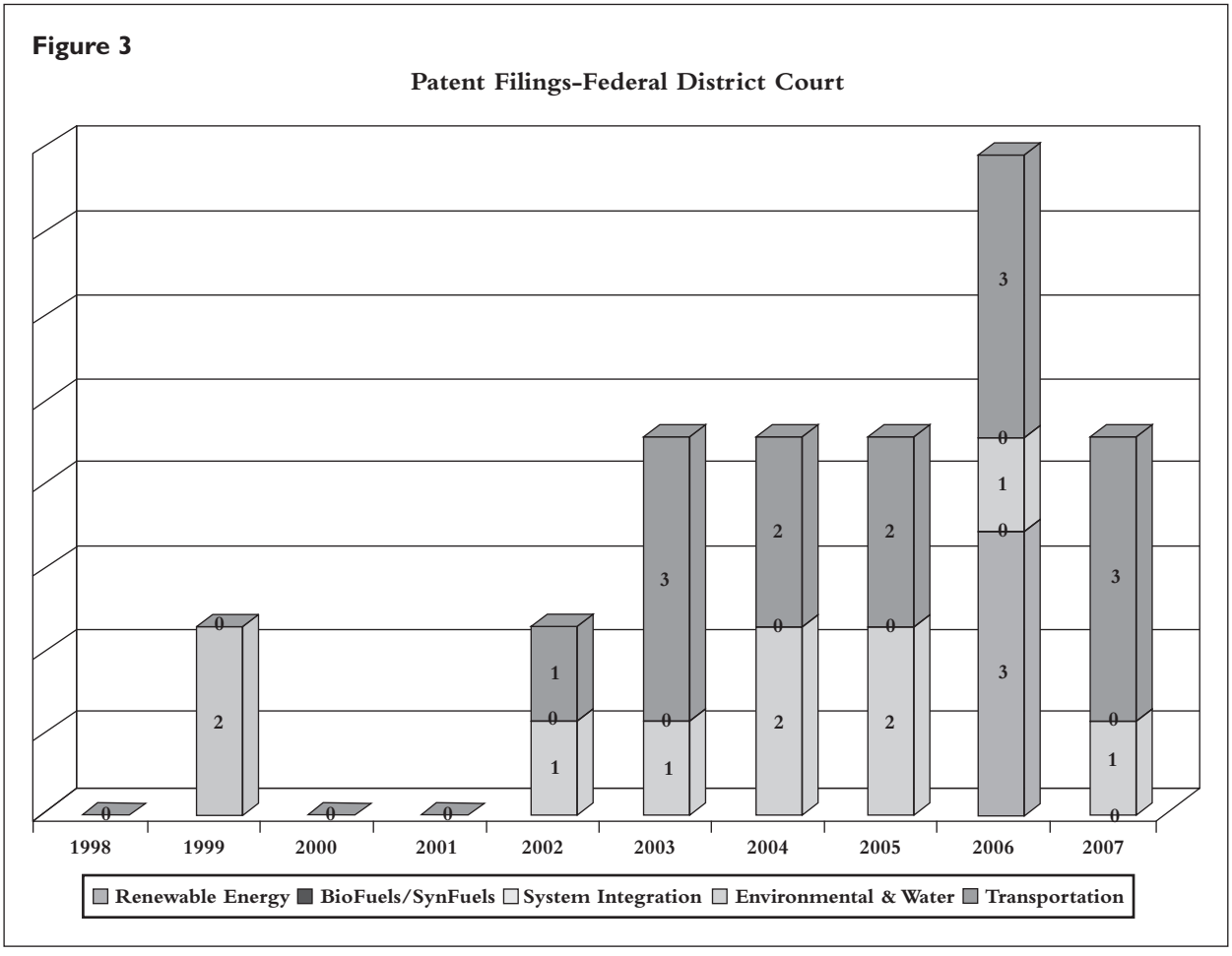
- Renewable energy sector (wind and solar);
- Biofuels/synfuels (biomass);
- System integration (energy storage);
- Environment and water (waste utilization and water treatment); and
- Transportation (hybrid electric vehicles and fuel cells).

Litigation Trends

Federal District Court

Similar to the difficulty in gathering precise prosecution statistics, there is no straightforward method to

Figure 3



obtain litigation data. Here, the data were obtained by conducting broad word searches of all US district court cases filed in the past decade. The cases were reviewed for relevancy, with each relevant case placed in one or more of the five segments identified above.

Figure 3 shows the very limited number of patent litigations filed in federal district courts over the last decade: 27 in all. The breakdown over the years is as follows: renewable energy (11); system integration (2); transportation (14); biofuels/synfuels (0); and environmental and water (0).

As the chart illustrates, more than half the total number of cleantech lawsuits have been filed since 2002. Before 1998, a mere eight cases were filed in all. The renewable energy lawsuits primarily involved solar and wind power. Fuel cells and hybrid vehicles were the popular subject matters in the transportation segment. The companies involved in all cleantech suits varied, with the automobile companies expectedly prevalent in the transportation segment.

International Trade Commission

There have been only two US International Trade Commission (ITC) § 337 investigations alleging patent infringement involving the cleantech industry since 1972, the date of the very first ITC investigation. The first cleantech investigation began on May 30, 1995, with Kenetech Windpower, Inc., as the complainant and Enercon GmbH and The New World Power Corporation as the respondents. After a violation was found, a limited exclusion order issued.

The second investigation began on February 13, 2006, with Solomon Technologies, Inc., as the complainant and Toyota Motor Corporation, Toyota Motor Manufacturing North America, and Toyota Motor Sales, U.S.A. as the respondents. The action involves hybrid drive technology. In April 2007, the ITC ruled against Solomon, which has since filed an appeal. A parallel action against Toyota in US district court has been stayed pending resolution of the ITC action.

Analysis

In the next decade, expect to see a greater increase in patent prosecution activity in the cleantech arena. With some 1,500 cleantech startups operating worldwide[5] and the $2.4 billion investors poured into them in 2006 alone, a great amount of research and development will be generated, and this research and development will in turn be patented. Additional patent activity will come from research and development spurred by national initiatives, such as Abu Dhabi's $15 billion Masdar projects,[6] and government projects, such as China's energy and environment projects for which China has earmarked $5.9 billion in 2008 alone.[7]

Innovation will continue to create new applications, reduce costs, and increase efficiency and performance. Many industries are expected to turn to cleantech to expand their businesses[8] and distinguish their products as energy-efficient or environmentally friendly or to simply reduce costs. As more products enter the marketplace, many cleantech sectors, especially those with vertical applications, will experience a wave of mergers and acquisitions,[9] with larger corporations taking over startups and their intellectual property. Anticipate more patents and trade secrets to be amassed by corporations via public auction.[10] This relatively new mechanism for publicizing and trading intellectual property may be particularly useful here as the data show that individuals own many cleantech patents.

The value of intellectual property in cleantech cannot be overemphasized. For example, in the energy sector, the success of a technology depends critically on the cost of producing the energy commodity. Any innovation that contributes to sustaining cost advantage of the technology against competing processes must be protected by patents or trade secrets. Also, for an early-stage company, considerable investment is expended to build or acquire assets for production; patents can mitigate the competitive risks faced by the venture. A young company cannot develop its technologies in all the markets at the same time. Therefore, it is important to develop a strategy for monetizing the intellectual property in as many fields of use and geographic territories as possible. It is crucial to file patent applications in developing countries like China where many of the cleantech applications should be deployed. If the technology is not properly protected, local competition can grow rapidly because of the home market. Once established, such local companies may export the technology to other countries. Although China has a short history of effective patent enforcement, it is foolhardy not to act now to secure protection of intellectual property for the future in this country.

With so much cleantech intellectual property in the hands of so many, it may be difficult for a company to see how best to license a product or where liability may lie. Thorough freedom-to-operate analyses will become critical for all participants in this space. In time, as the market matures[11] and competition intensifies, litigation will dramatically increase. In the United States, such lawsuits may come as a result of the greater ease with which an accused infringer can now file suit for declaratory judgment, per *MedImmune, Inc.*

v. Genentech, Inc.[12] Or they may come as preemptive filings, that is, as a result of the patentee affirmatively seeking to sue first in its chosen forum and then initiating contact with the accused infringer to negotiate a license. In *MedImmune*, the Supreme Court allowed the licensee to assert in a declaratory judgment suit that the patent underlying the license is invalid, unenforceable, or not infringed, even though the licensee continued to make royalty payments and did not terminate its license. A Federal Circuit decision has since ruled that a potential licensee may file a declaratory judgment action despite a patentee's statement not to sue during license negotiations.[13] Moreover, an accused infringer may be more willing to sue for declaratory judgment of invalidity in light of the Supreme Court's decision in *KSR International Co. v. Teleflex Inc.*,[14] which may make it easier to prove obviousness. There, the Supreme Court found the Federal Circuit's teaching-suggestion-motivation test to be too rigid, favoring a more flexible approach.

Given the number of patents held by individuals, it is also expected that some of these lawsuits will be filed by nonpracticing, patent-holding entities against established manufacturers, such as those in the car industry. However, in *eBay Inc. v. MercExchange, L.L.C.*,[15] the Supreme Court put an end to the "general rule" that a permanent injunction should follow a finding of infringement of a valid patent. Whether an injunction should issue is now within the trial court's discretion, and it will be much more difficult for a non-rival to obtain an injunction.[16] Due to the latter reason alone, more ITC investigations should be filed as these quick proceedings offer an exclusion order as the primary remedy.

With energy costs and climate change high on the list of public and governmental concerns, cleantech is a priority on the research and development agenda of many global corporations. Continuing investments and competition in the cleantech industry will drive growth in patent prosecution and litigation for many years to come.

Notes

1. There is no standard definition of "clean technology" or "cleantech." The term is used to describe a diverse range of products, processes, or services that improve efficiency, productivity, or performance while reducing costs, input, energy consumption, waste, or pollution.
2. A US Patent Classifications (USPC) is typically expressed by a first number that represents the class of invention, a slash, and a second that represents the subclass of invention within the class. Each US patent is classified at the subclass level. There are about 450 classes of invention and about 150,000 subclasses of invention. The International Patent Classification (IPC) separates the whole body of technical knowledge using four hierarchical levels (section, class, subclass, group (and one or more subgroups)), expressed in a combination of letters and numbers. There are no direct correspondences between the hierarchies of the USPC and IPC, but a USPC-to-IPC concordance is published by the PTO.
3. The IEA is an autonomous body established in November 1974 with 26 member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. The European Commission takes part in the work of the IEA. "Renewables in Global Energy, An IEA Fact Sheet," January 2007.
4. Of course, a patent can be assigned after issuance, but the searches are not intended to track whether a patent that issued without an assignee was later assigned.
5. "The Cleantech Report," Lux Research Inc.
6. The Masdar Initiative received the "Cleantech Leader of the Year" award on February 26, 2008, at the Cleantech Forum's Cleantech Awards in San Francisco.
7. China announced that the funds will be used to scrap obsolete power generating capacity, improve sewage systems, and clean up several rivers across the country. *Reuters*, March 24, 2008, by Eadie Chen.
8. By 2015, DuPont plans to generate $6 billion in annual revenue from cleantech products. Honda now has a wholly owned solar subsidiary. Tyson Foods has formed Tyson Renewable Energy to turn 2.3 billion pounds of animal fat into 300 million gallons of biofuels a year. "Clean Energy Trend," Mar. 2007, Clean Edge.
9. Applied Materials has already acquired Applied Films, a publicly traded manufacturer of thin-film solar manufacturing equipment, and announced plans to have a $500 million-a-year solar division by 2010. Iberdrola, one of the world's largest renewable energy operators, announced plans to acquire ScottishPower and its major wind power assets. Iberdrola has already purchased three US wind-park developers. *Id.*
10. The catalog for Ocean Tomo's spring 2008 live auction (April 1, 2008) lists, for example, patents related to solar photovoltaic manufacturing technology.
11. For example, biofuels, wind power, solar photovoltaics, and the fuel cell and distributed hydrogen market totaled $39.9 billion in 2005, expanded 39 percent to $55.4 billion in 2006, and are expected to quadruple to more than $226.5 billion within a decade. *Id.*
12. MedImmune, Inc. v. Genentech, Inc., 127 S. Ct. 764 (2007).
13. SanDisk Corp. v. STMicroelectronics, Inc., 480 F.3d 1372 (Fed. Cir. 2007).

14. KSR International Co. v. Teleflex Inc., 127 S. Ct . 1727 (2007).
15. eBay Inc. v. MercExchange, L.L.C., 126 S. Ct. 1837 (2006).
16. For example, in Paice, LLC. v. Toyota Motor Corp., 504 F.3d 1293 (Fed. Cir. 2007), the Eastern District of Texas held that Toyota's hybrid drive train infringed one of Paice's patents but did not grant a permanent injunction. In October 2007, the Federal Circuit affirmed but vacated and remanded the award to Paice of an ongoing royalty of $25 per infringing vehicle.

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