

CLEAN ENERGY PATENT GROWTH INDEX (CEPGI)



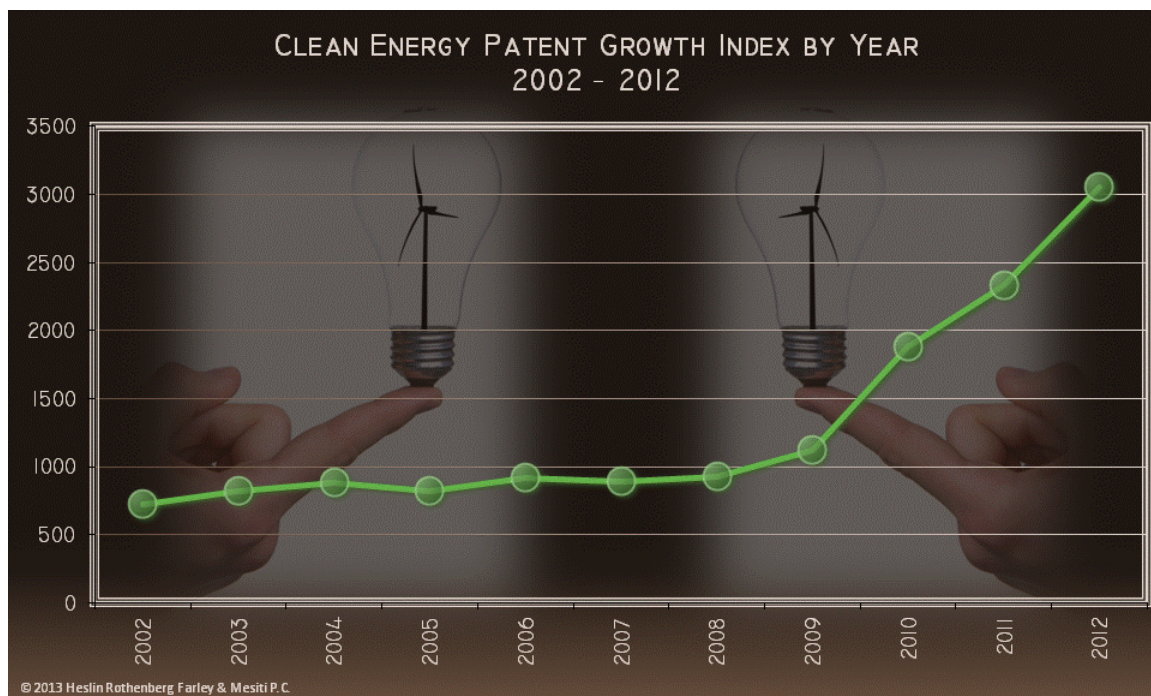
2012 Year in Review

Presented by the Cleantech Group -
Heslin Rothenberg Farley & Mesiti P.C.
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The CLEAN ENERGY PATENT GROWTH INDEX (CEPGI), published quarterly by the Cleantech Group at Heslin Rothenberg Farley & Mesiti P.C. provides an indication of the trend of innovative activity in the Clean Energy sector from 2002 to the present. The CEPGI also ranks the leaders among Clean Energy Patent Owners, along with the Countries and the U.S. States which receive the most clean energy patents.

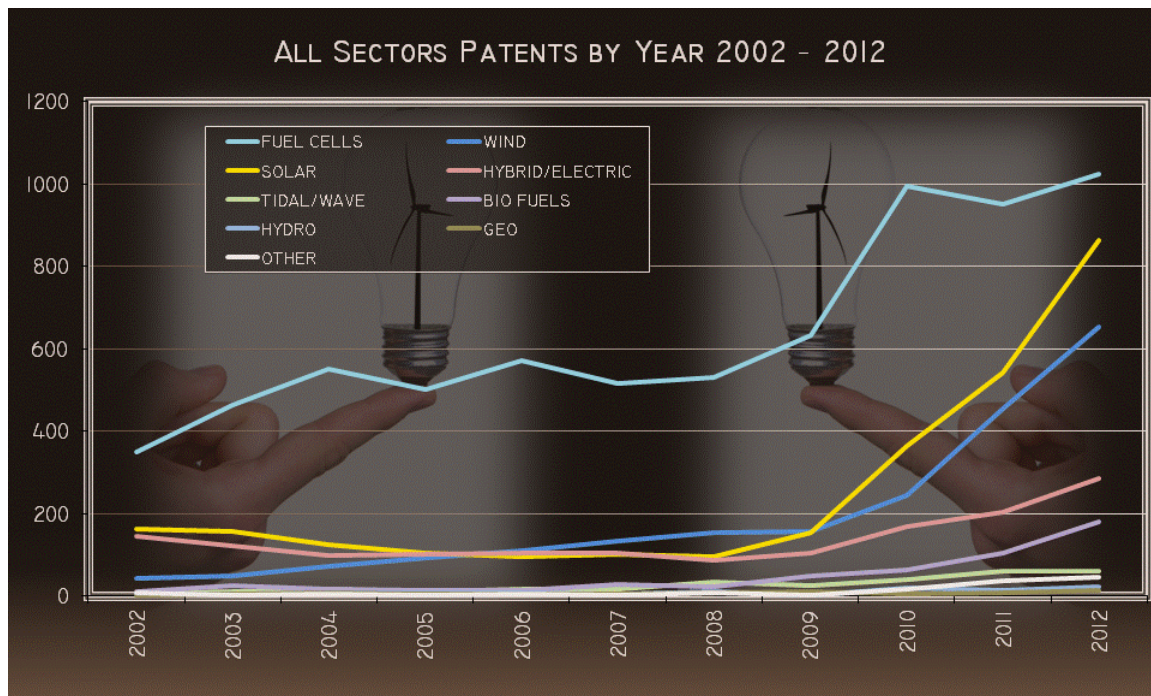
The granting of patents by the United States Patent and Trademark Office (PTO) is often cited as a measure of the inventive activity and evidence of the effectiveness of research & development investments. Patents are considered to be such an indicator, because to be awarded a patent, it requires not only the efforts of inventors to develop new and non-obvious innovations but also successful handling by patent counsel to shepherd a patent application through the PTO. Thus, the granting of a patent is an indicator that efforts at innovation have been successful and that an innovation had enough perceived value to justify the time and expense in procuring the patent.

The CEPGI (shown below annually) tracks the granting of U.S. patents for the following sub-components: Solar, Wind, Hybrid/Electric Vehicles, Fuel Cells, Hydroelectric, Tidal/Wave, Geothermal, Biomass/Biofuels and other clean renewable energy.



U.S. patents for clean energy technologies in 2012 were at an all time high of 3061, jumping 730 patents, or more than 30 percent, over 2011, which is the second largest year-to-year jump, lagging only the 2010 to 2011 jump of 756 patents.

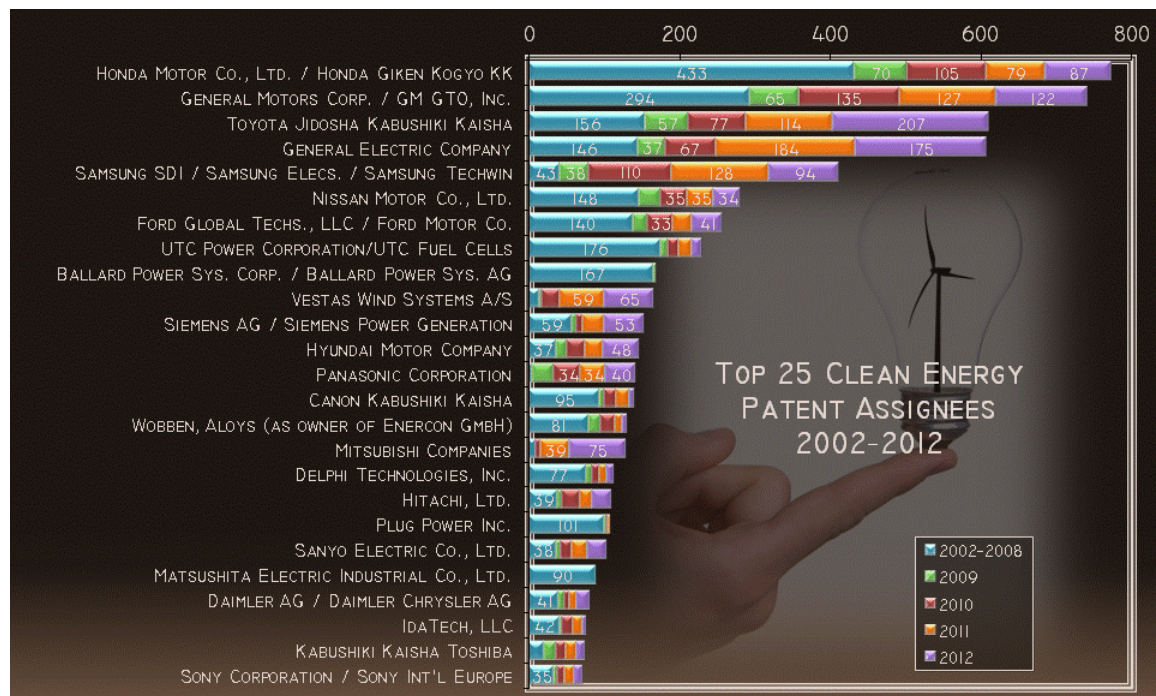
As depicted in the below breakdown of the CEPGI by its sub-components, patents in Biomass/Biofuel technologies were up over 70 percent followed by Solar patents at over 60 percent. Wind patents and Hybrid/Electric Vehicle patents were up over 40 percent. Although being the largest component of the CEPGI by far, Fuel Cells in 2012 were up a less-earth-shattering 8 percent. Tidal/Wave Energy patents were up only one patent while Geothermal patents doubled to 14. Hydroelectric technologies were up 6 patents.



The Fuel Cell sector was again the big winner among the components of the Clean Energy Patent Growth Index, with 1024 patents topping Solar patents (862) by over 160 patents. It is worth noting that Solar patents in the 4th quarter were only 5 away from Fuel Cell patents leading one to believe that the race for the top spot in the CEPGI may become more competitive in 2013. Solar, Wind and Hybrid/Electric Vehicle patents reached new highs in 2012 despite losing out to Fuel Cells in the patent race. Solar patents again topped Wind patents in 2012, by over 200 patents, despite Wind patents increasing by almost 200 patents last year. Solar's gain in 2012 was also impressive, gaining more than 300 patents in one year. Patents in Hybrid/Electric Vehicles jumped to 286 patents in 2012 from 203 the year before.

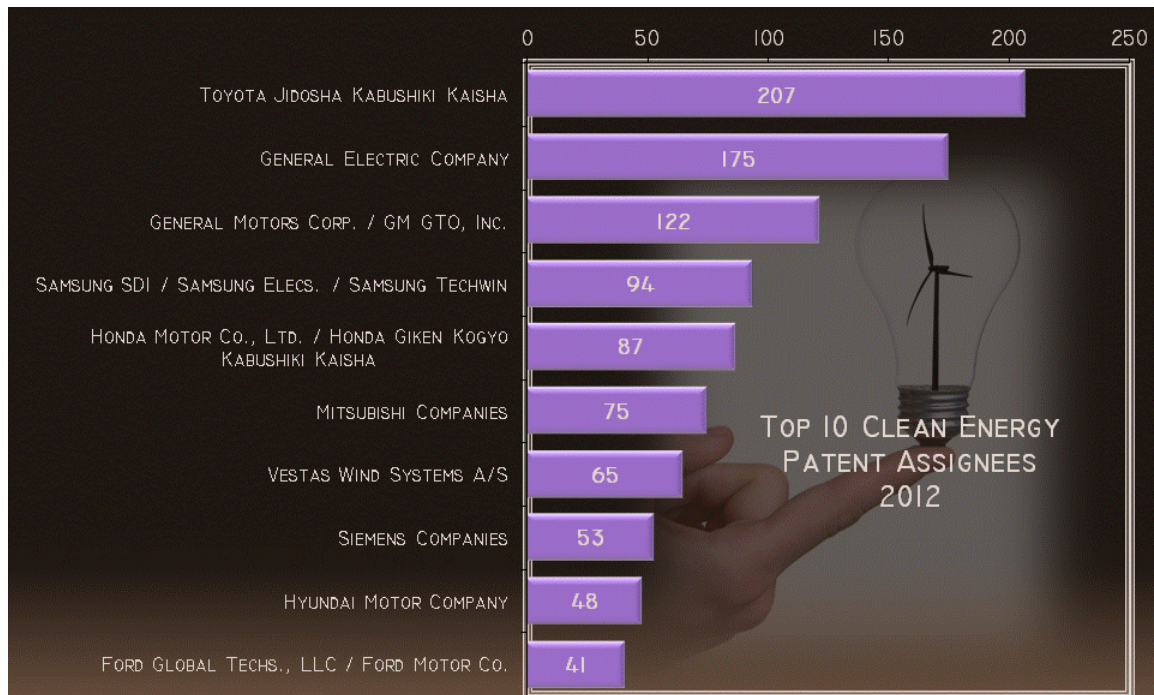
As indicated above, Fuel Cell technologies dominate the patent race but Solar technologies could be catching up. Solar has pulled ahead of Wind such that Solar and Wind were separated by over 200 patents. Wind outclassed Hybrid/Electric Vehicles by an even more substantial nearly-400 patents. Biomass/Biofuel patents led the lower tier at 179 patents followed by Tidal energy patents at 61. Biomass/ Biofuel patents are currently at about the level that some of the leaders were 5 to 6 years ago. Also, Hydroelectric had 21 patents (up 6) and Geothermal 14 (up 7).

The top patent owners since 2002 are shown below, ranked relative to total number of patents, and also annotated to show the particular totals for the last several years and a cumulative total for earlier years:



As is evident from the chart above, Honda continues to lead in overall clean energy patents granted since 2002 but is losing ground every year to others. GM is right behind Honda and Toyota has moved into third place while GE fell to fourth. GE has more clean energy patents than any other (see orange and purple) over the last two years followed closely by Toyota. Five of the top ten overall clean energy patent holders are auto manufacturers with the other five including an assortment of wind, solar and fuel cell makers. Canon fell out of the top ten overall while GE had new patents in Solar and Wind. Ballard was barely able to hang on in the top ten with no additional contribution from 2012. Vestas took tenth place overall, jumping a few places due to a strong 2012 showing. Samsung again put up impressive numbers in 2012 to stay in the fifth spot overall.

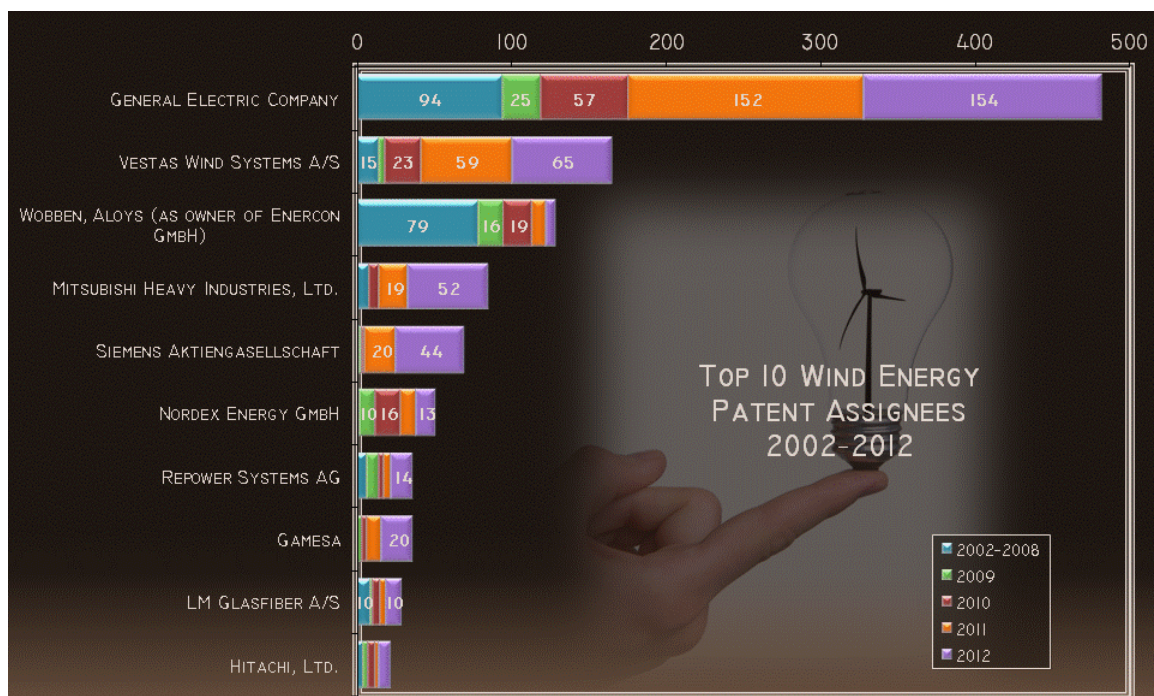
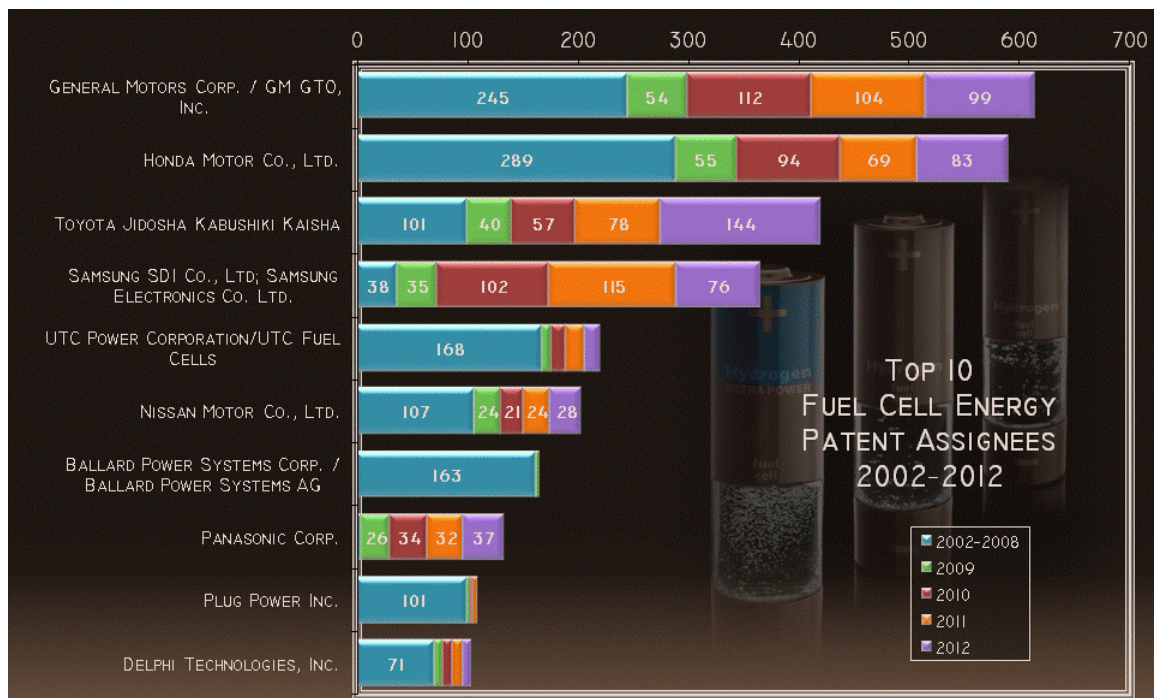
Looking only at 2012 (below), over 1000 entities contributed to the record total of clean energy patents in 2012 which is 200 more patent grantees than 2011. A “Prius effect” resulted in Toyota’s 207 patents taking the top spot in 2012 from last year’s winner, GE (175). 2010’s winner GM was in third place in 2012. Samsung (94) fell to the 4th spot in 2012 down two spots from last year. Ford (41) moved into the top 10 while Nissan fell out leaving a constant five of the top ten leaders as auto companies. Vestas’s Wind patents landed it in 7th place with 65 patents. Siemens followed in 8th place also with Wind patents (53). Honda’s 5th place showing was based on its 87 clean energy patents. Where Honda’s 70 patent showing in 2009 was enough to garner the leader’s spot, the recent explosion in patents by others has left Honda behind. It is interesting that no pure Solar companies made the top ten although GE and Mitsubishi had some patents in this area.



We will now look in more detail at each of the CEPGI's major components along with the top patent owners and geographical areas.

As depicted below in the Fuel Cell patent owner breakdown, GM remained ahead of Honda for the second year to take the all time Fuel Cell leader crown but Toyota dominated all others in 2012 with 144 leading GM by 45 Fuel Cell patents. Honda (83) and Samsung (76) took third and fourth places in 2012. The top four overall and top four in 2012 were the same companies but the order differed. Panasonic and Nissan were further below at 37 and 28 Fuel Cell patents respectively in 2012. Hyundai also had 25 patents while Bloom energy had 20 in 2012. Daimler (15) and 3M (11) rounded out the top 10 in 2012.

Returning to the overall totals for Fuel Cells, Toyota and Samsung swapped third and fourth place relative to 2011. Plug Power and Panasonic also traded placed in the overall totals with the remaining patent owners holding their own in the overall Fuel Cell rankings. As is evident from the chart, Plug Power, Ballard, UTC, and Delphi have many patents in the 2002-2008 time period but comparatively less in the more recent years.



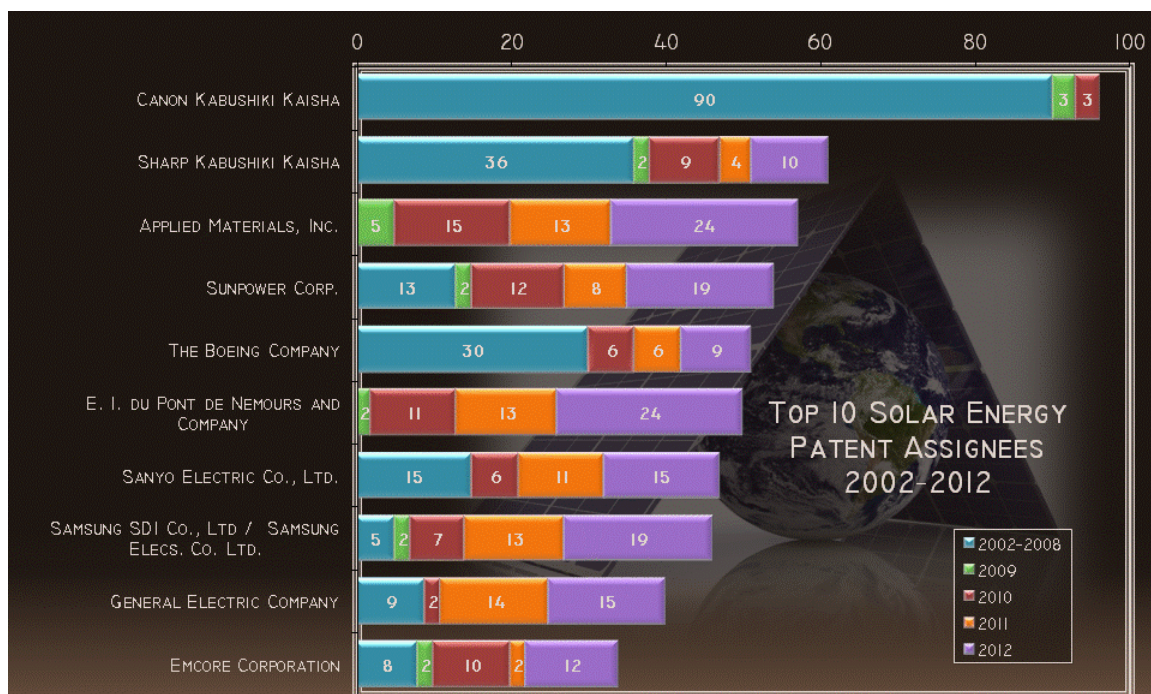
2011 Wind patent leader GE dominated the 2012 rankings along with the overall year-to-date Wind numbers. GE topped 150 patents for the second straight year in 2012 at 154 and had over 2 1/2 times the Wind patents as its nearest 2012 rival Vestas (65) which moved up a spot to second place overall as depicted above. Vestas was up 6 patents over 2011. Alloy Wobben fell to third place overall. Mitsubishi (52) and Siemens (44) took third and fourth place in 2012 (and more than doubling their 2011 totals) while taking the fourth and fifth places overall. Looking at 2012 only, Gamesa (19), Repower (14), Nordex (13), and LM Glasfiber (10) followed in the 5th-8th spots. A newcomer to the Wind rankings was wind turbine blade innovator Frontier Wind (7), followed by Hitachi,

Gerald Barber (head of gearbox-free wind turbine developer, Barber Wind), Fuji and Alloys Wobben with 6 Wind patents.

The 2012 race for Solar patents presents a contrast with the Wind patent race. As indicated above, GE led all others in Wind patents in 2012 with 154 patents. In contrast, GE also led Solar patent grantees in 2011 but with only 14 patents while receiving 15 Solar patents in 2012 but not the Solar crown. Instead, in 2012, 24 Solar patents was enough to take the crown despite 200 more Solar patents being granted than Wind patents. About 400 different entities received solar patents in 2012 compared to only around half that number receiving Wind patents.

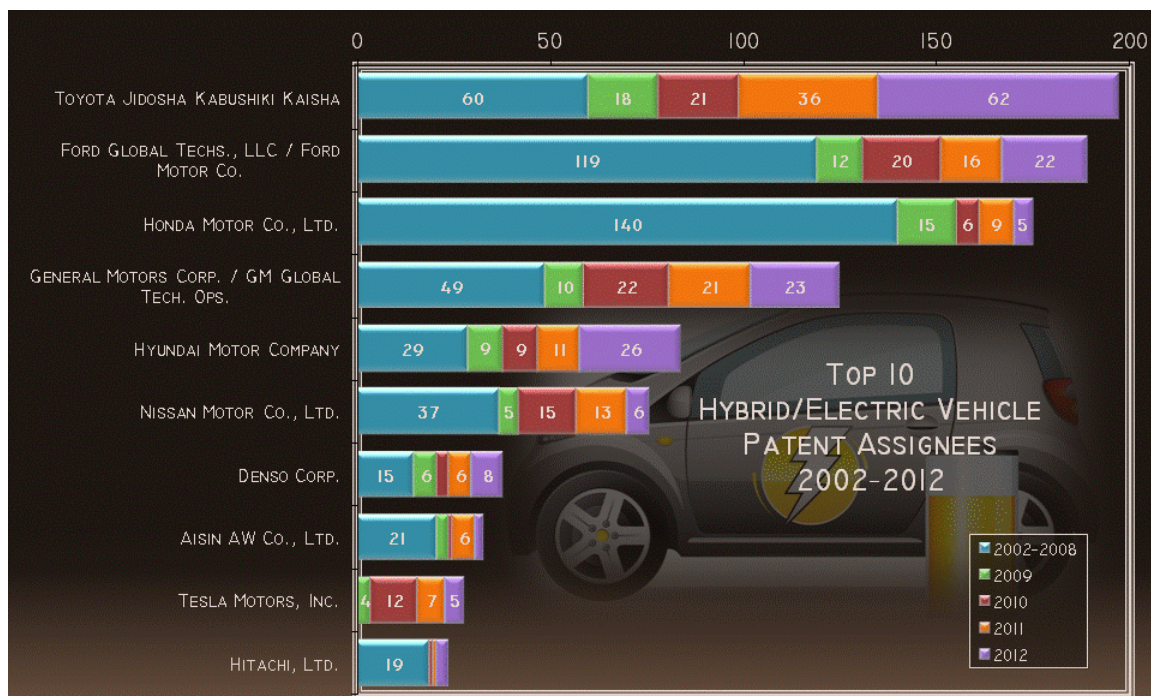
Applied Materials and Dupont tied for the total number of Solar patents in 2011 and 2012 combined. Both took the leader's spot in 2012 while GE dropped to fifth, tying Sanyo despite having one more patent (15) than the year before. Samsung and Sunpower tied for third place with 19 Solar patents granted. Solopower (14), LG (13) and Emcore (12) followed GE and Sanyo. A newcomer but familiar name, IBM, took tenth place with 11 Solar patents.

In patents since 2002, Canon continues to lead the rankings despite accruing no patents since 2010. Sharp follows after accruing 10 new patents in 2012, as mentioned above. As depicted in the chart the vast majority of Canon's Solar patents are older patents. Beyond Canon and Sharp, the overall rankings in Solar are relatively fluid. Boeing dropped from third to fifth while Applied Materials and Sunpower jumped ahead. The preponderance of newer patents (and associated coloring) is especially prominent on the overall Solar chart in contrast to some of the other technologies. Dupont jumped three places to sixth. Sanyo dropped a spot to 7th and Konarka fell out of the top ten overall since last year. GE jumped to 9th place overall while tenth was taken by Emcore.



The long awaited "Prius" effect has vaulted Toyota to the top of the overall and 2012 Hybrid/Electric Vehicle patent rankings. After a long reign, Honda has dropped to third in the overall rankings. Ford remains in second overall followed by Honda, GM and Hyundai. The leaders in 2012 and overall look almost the same except for Honda which had only 5 Hybrid/electric vehicle patents in 2012.

Toyota dominated all others in 2012 with over twice the number of its nearest competitors. Hyundai was in second place with 26 patents, more than doubling its 2011 total, and was followed by GM (23) and Ford (22). Separated by a wide margin from the leaders in 2012 and rounding out the top ten were Mitsubishi (9), Denso (8), Nissan (6), German vehicle transmission supplier ZF Friedrichshafen AG (6), Tesla (5), and Honda (5).



Also, although not depicted above, Ocean Power Technologies continues to lead in the Tidal/Wave sector since 2002 picking up 1 patent in 2012 and has a total of 19 since 2002. Lockheed Martin had three patents in 2012 and Huntington Ingalls had two. Over 50 other different entities had patents in this area last year. In Hydroelectric patents, Hydro Green Energy had two patents and 19 assignees, including GE had one patent each.

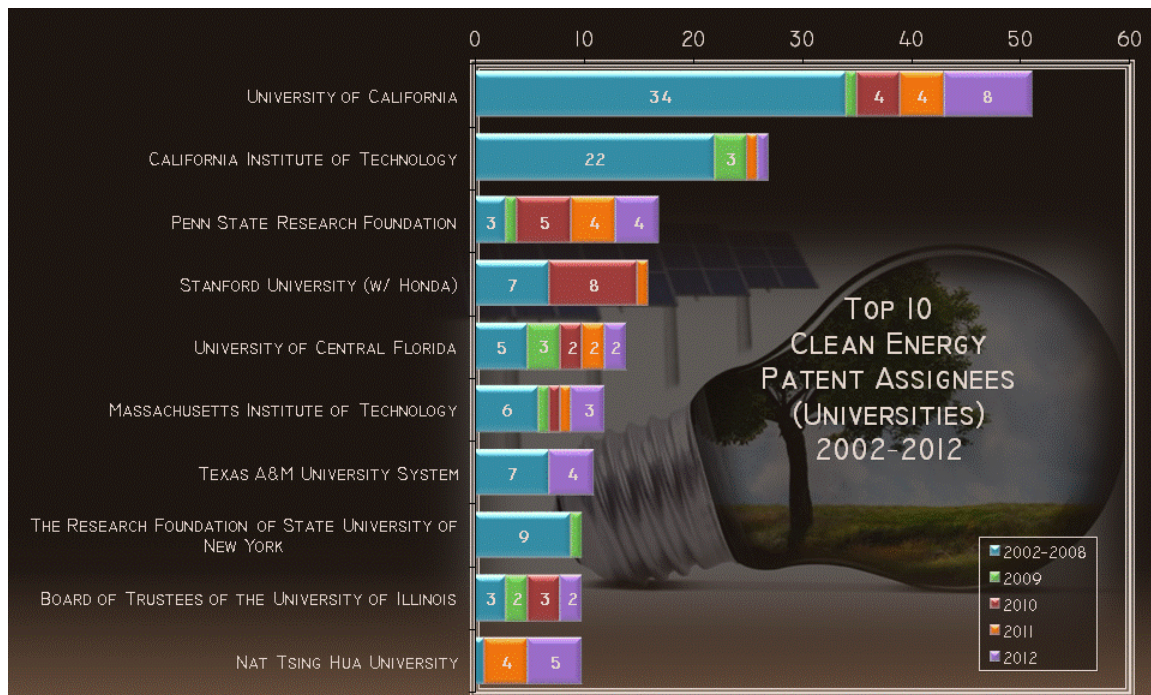
Three Geothermal patents were granted in 2012 to Canyon West Energy while 11 other entities each received one patent. Kalex, LLC continues to lead in Geothermal patents (8) overall since 2002 despite not having any patents in 2008-2012. Ormat moves into second with one patent in 2012 for a total of four. GE, Canyon West, Kimberly Peacock and Nuovo Pignone S.p.A. each have 3 total Geothermal patents since 2002.

In the Biofuel/Biomass area, the 2012 race wasn't even close. Heliae Development, a newcomer in 2012, had 19 patents, while Bio Architecture Lab was a distant second with 5. LS9, UOP and BAST each had 4, while Sapphire Energy teamed up with the Scripps

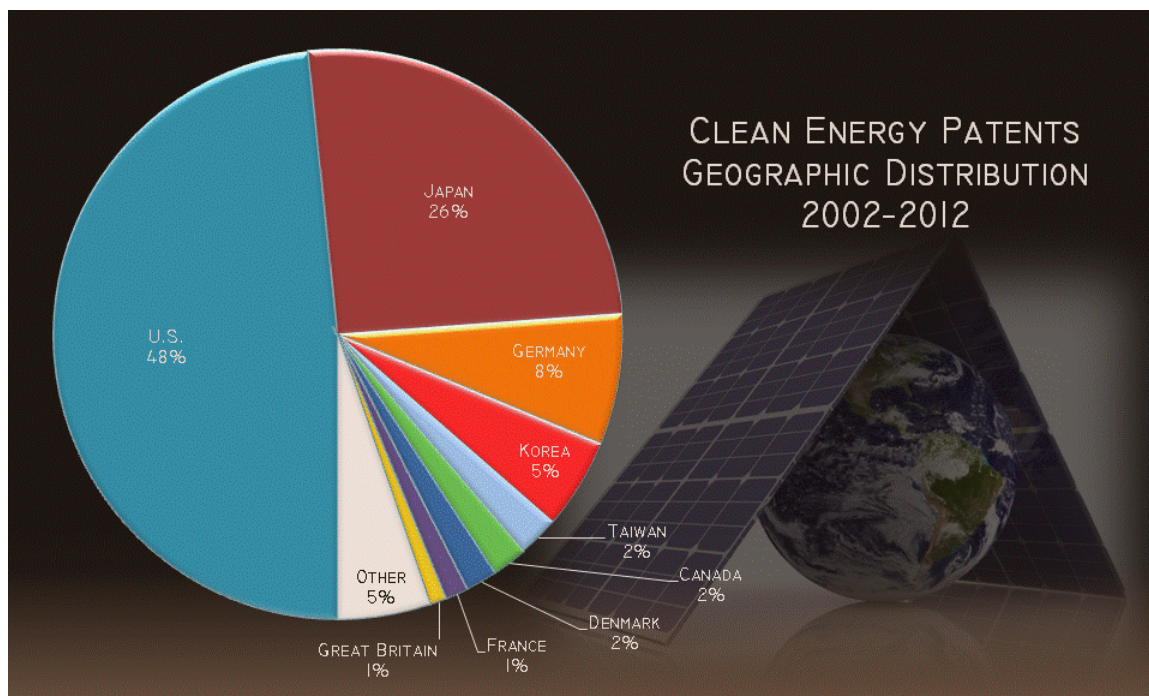
Research Institute for 3 patents. Chevron and Texas A&M University also received 3 patents. Heliae's 19 patents in 2012 alone were enough for the overall crown. Chevron fell back to second with 10. UOP and Virent Energy Systems were tied for third with 7 and Bio Architecture Lab and Wisconsin Alumni Research Foundation each had 6.

In 2012 the University of California led all challengers with 8 patents while Nat Sing Hua University of Taiwan had 5 for second. There was a three-way tie for third with Wisconsin Alumni Research Foundation, Texas A&M and Penn State Research Foundation.

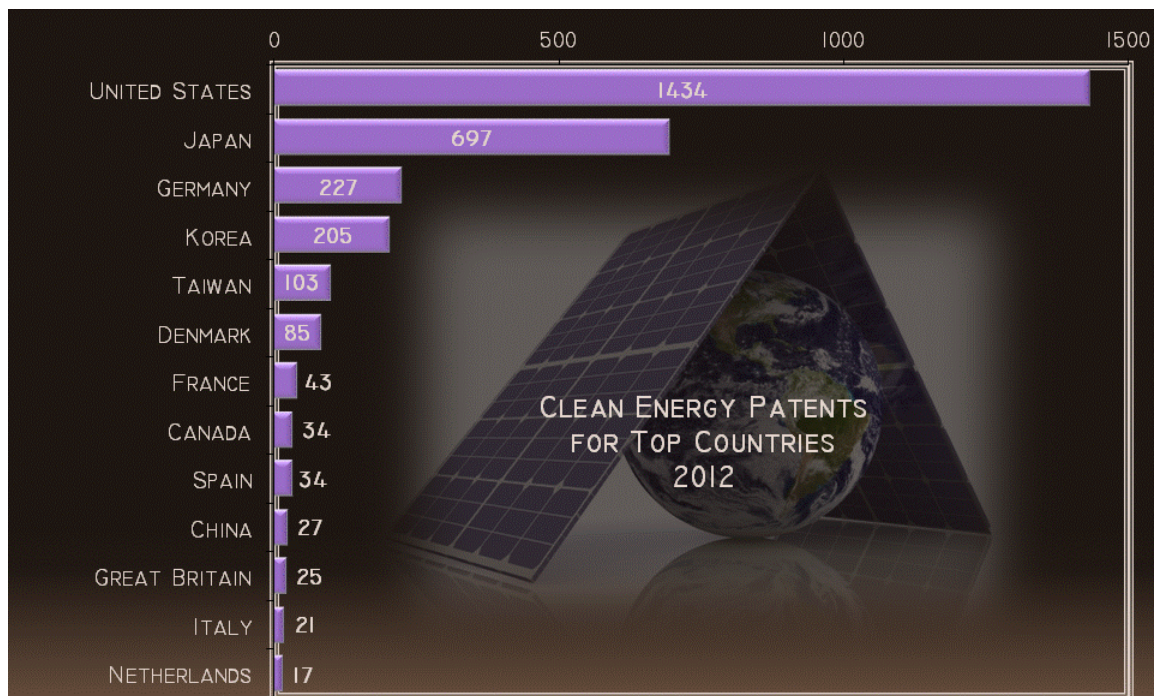
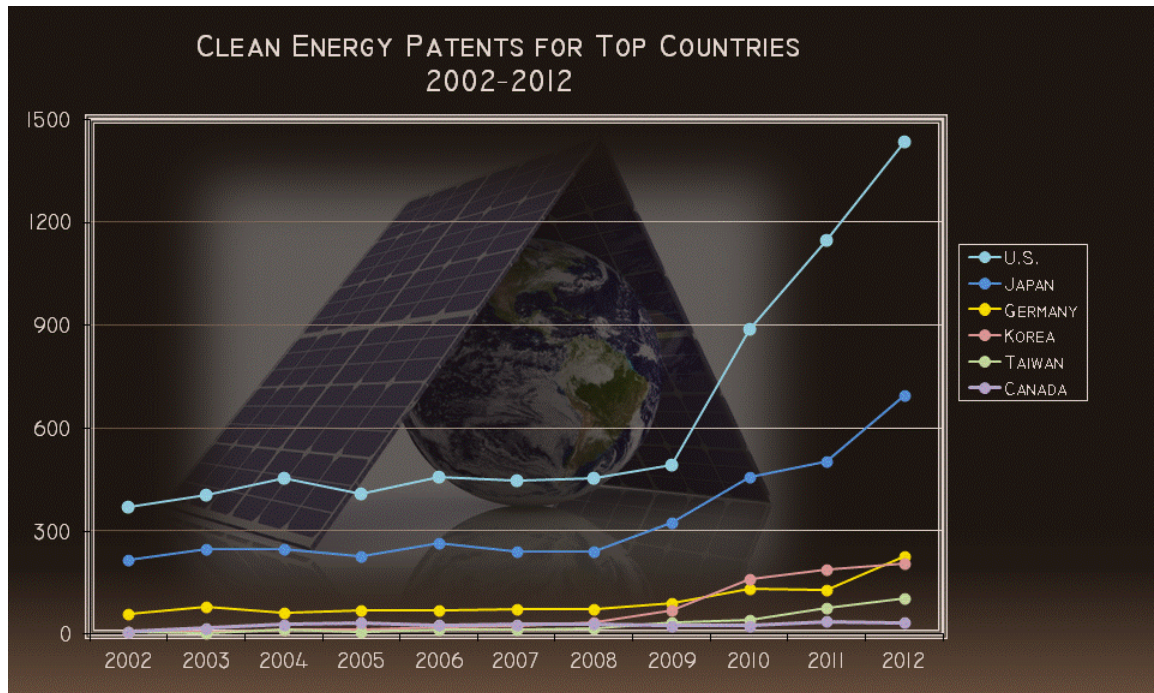
Cumulatively since 2002, University of California (51) and California Institute of Technology (27) remained in the top two slots. Penn State Research Foundation (17) moved from sixth into third, bumping Stanford University (16) down to fourth, and Central Florida (14) down to fifth. Meanwhile, the Research Foundation of State University of New York (10) hasn't received a clean energy patent since 2009 and fell to a tie for eighth; getting passed along the way by the previously-mentioned Penn State, as well as MIT (12) in sixth and Texas A&M (11) in seventh. The University of Illinois and National Tsing Hua University of Taiwan (both new to the top 10) were also tied with 10 patents each.



Turning to the geographical extent of U.S. clean energy patents, U.S. patent owners had slightly less than the rest of the world in the number of U.S. patents granted in the clean energy field over the period 2002-2012 with 48 percent of the granted U.S. patents as depicted below. Patent applicants from Japan (26 percent) and Germany (8 percent) were issued the second and third largest number of U.S. patents since 2002. South Korea, Taiwan, Canada, and Denmark followed as depicted.

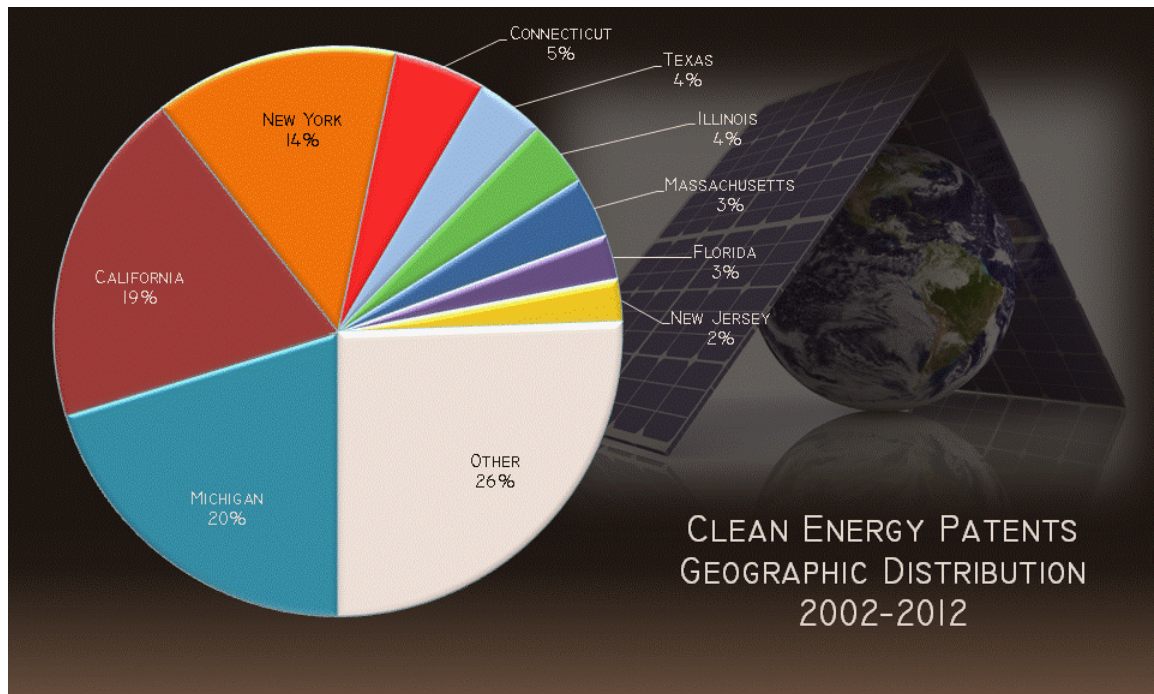


In 2012 U.S. entities had less clean energy patents than the combined total of all other countries receiving clean energy patents in the United States by a margin 1627 to 1434. As depicted below in the line chart, the US and Japan continue to dominate all others in the number of granted US clean energy patents with both having sharply upward trajectories. As illustrated, the US in particular has accelerated rapidly since 2010. Germany (at 227; 98 more than in 2011) and Korea (205) outshone the remaining countries in 2012. As indicated in the top ten chart below, other non-US top patent owners of US patents include Taiwan 103 (up 28), Denmark (85), France (43), Canada and Spain (34), China (27), Great Britain (25), Italy (21), and the Netherlands (17). It is interesting to note that Germany entities had about as many US Clean Energy patents as the rest of the top European countries combined.

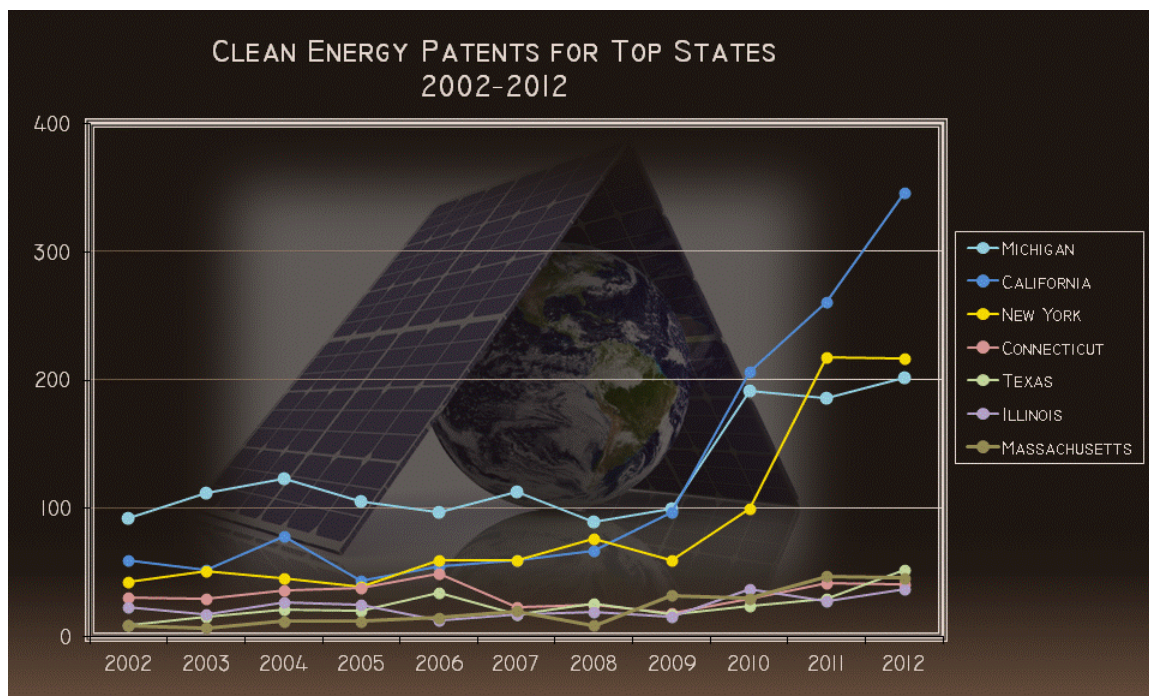


The big US industrial states also continue to dominate the Clean Energy patent rankings. Michigan leads the U.S. states in the Clean Energy area since 2002 at 20 percent of the U.S. clean energy patents largely based on the Fuel Cell and Hybrid/Electric Vehicle activities of US car manufacturers - falling two percent compared to its share last year. California's share rose to 19 percent while New York held at 14 percent of the US clean energy patents granted since 2002. California entities have patents in Hybrid/Electric

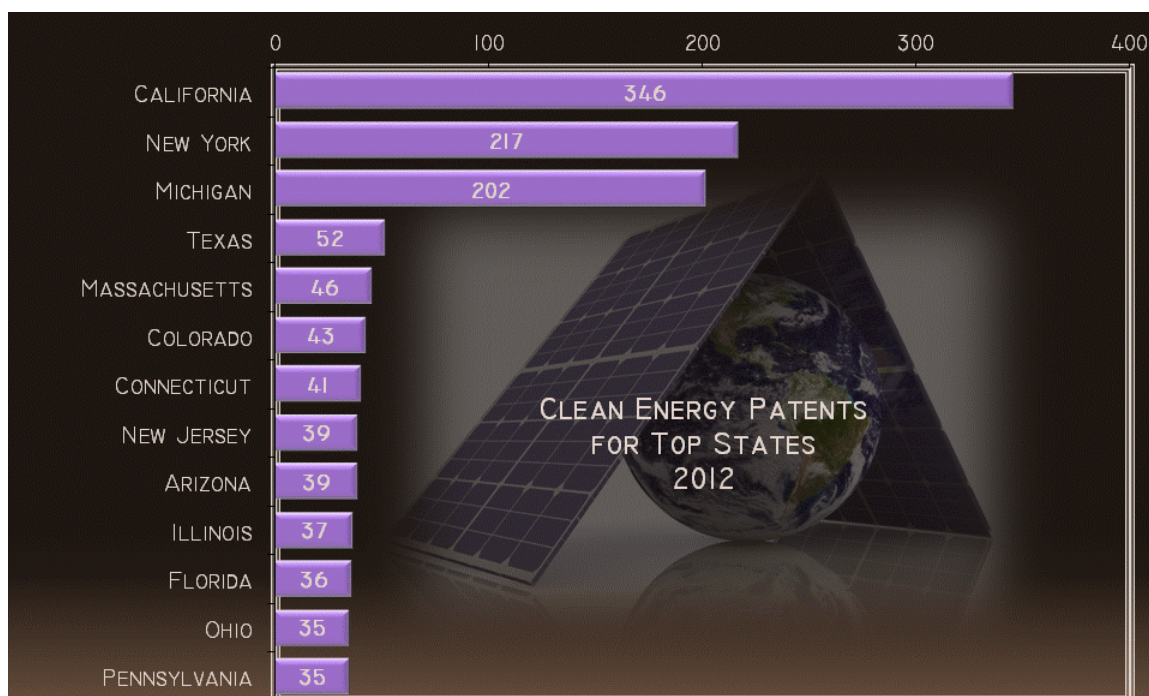
Vehicles, Solar technologies and Fuel Cells, among others, and New York companies have patents in Wind technologies and Fuel Cells. Connecticut has 5 percent (down 1) of US entities' granted clean energy patents since 2002 with most of those being Fuel Cell patents to UTC. Texas and Illinois stayed at four percent while Massachusetts, Florida and New Jersey followed.



Looking at 2012 and the line chart below, California continued its sharp rise with 345 clean energy patents, up 84, to take the States' Clean Energy Patent Crown while New York (217) dropped one patent relative to 2011 but maintained its lead over Michigan which jumped 16 patents to 202.

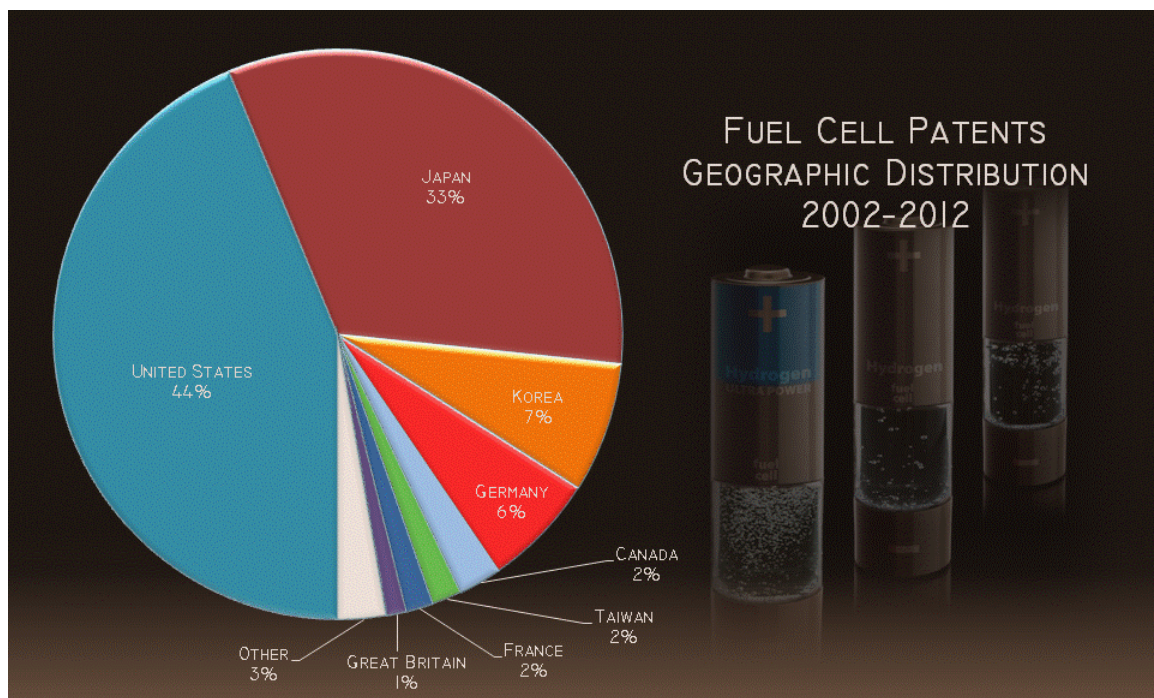


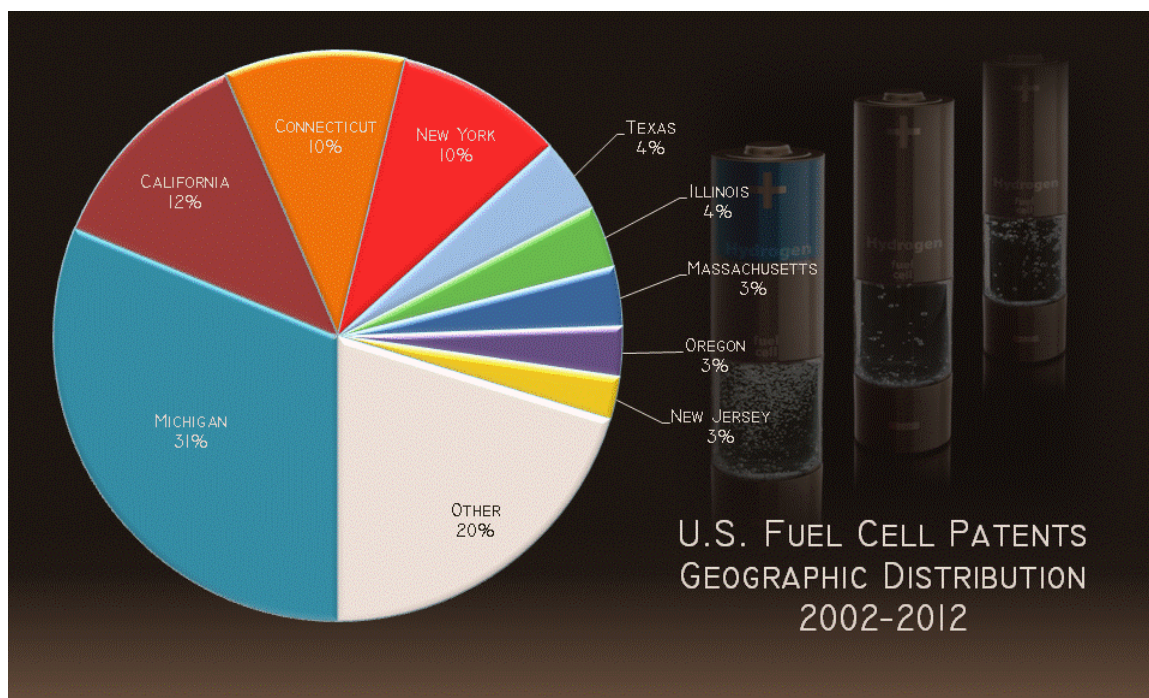
Looking at the charts of the top US states, Texas was in fourth place, far below Michigan's 202 Clean Energy patents in 2012, and up 22 to 52 clean energy patents. Across the country, Massachusetts was down one patent relative to 2011 to 46. Colorado doubled its number of clean energy patents in 2012 relative to 2011 with 43. Connecticut dropped a patent to arrive at 41 while New Jersey jumped 12 to 39 clean energy patents. Arizona jumped 30 patents to 39. Illinois had 37 clean energy patents (up 9) while Florida (up 9) finished in the tenth spot at 36 granted clean energy patents.



If instead of looking at individual countries versus the U.S. as a whole, we look at the top U.S. states individually (i.e., separately from the U.S. as a whole) and foreign countries in 2012, Japan led the field with 697 patents followed by California at 345, about half of the Japanese total. New York was in third (217) followed by Germany at 227 (98 more than in 2011). Korea was at 205 clean energy patents followed by Michigan with 202 in sixth place. Taiwan and Denmark followed at 103 and 85 clean energy patents, respectively. Texas and Massachusetts came in ninth and tenth place among clean energy geographic areas at 52 and 46 clean energy patents, respectively.

As depicted below, Fuel Cell patents since 2002 are dominated by the U.S. and Japan, followed by Korea and Germany. The U.S. leads the world with 44 percent of U.S. patents in Fuel Cells followed by Japan with 33 percent, while Korea and Germany hold 7 and 6 percent, respectively. Within the U.S., Michigan (31 %), California (12%), Connecticut (10%), and New York (10%) lead in overall Fuel Cell patents granted since 2002.

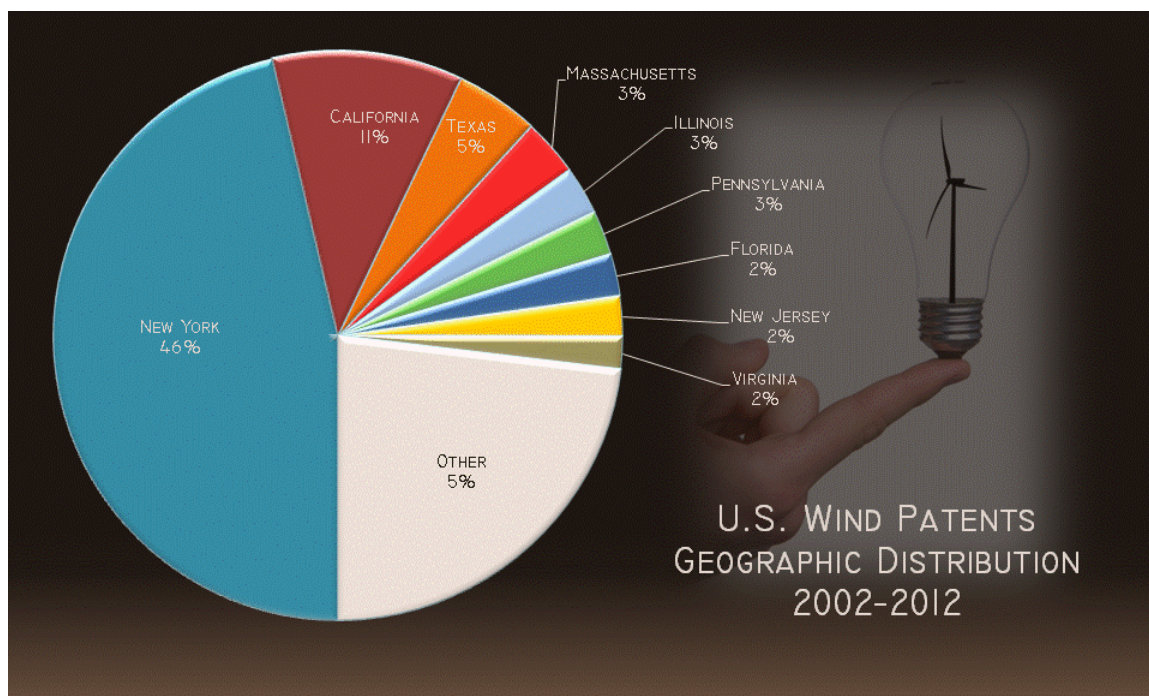
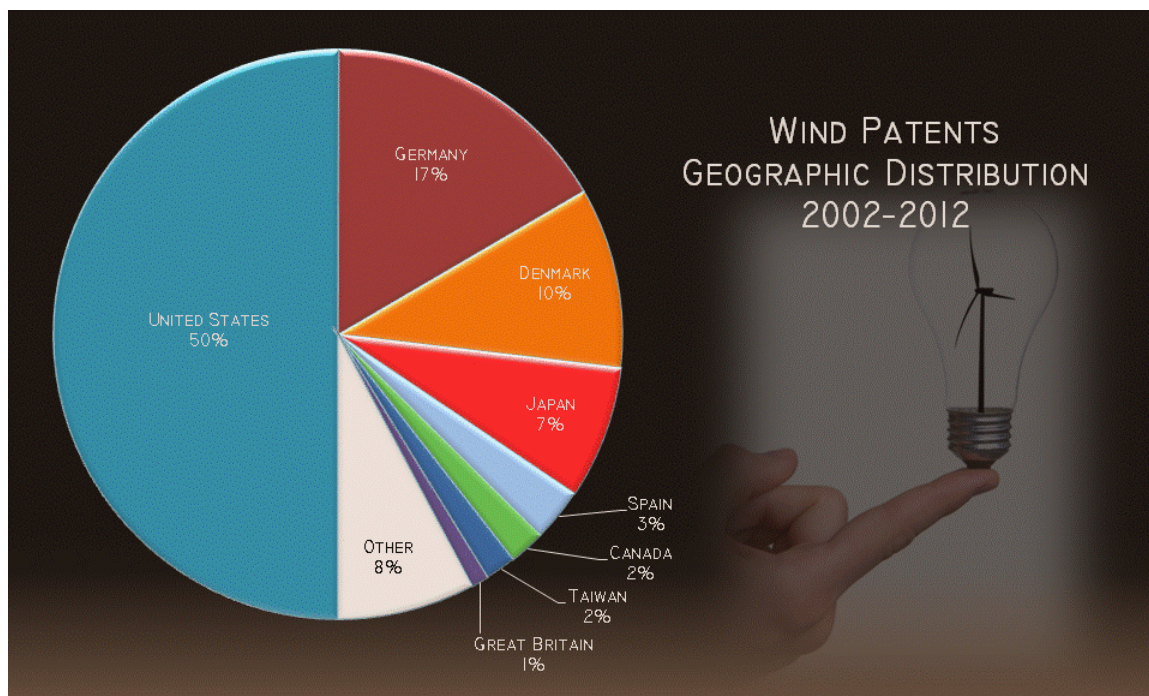




In 2012 the U.S. (322) dropped 37 patents relative to the year before and trailed Japan (434) in U.S. Fuel Cell patents for the first time since 2009. Korea followed with less than a third of Japan's total at 120 Fuel Cell patents (down 23) and Germany had less than a half of that at 51 Fuel Cell patents which is 17 more than last year. France jumped one Fuel Cell patent to 24 and fell behind Taiwan (26) which jumped 4 patents relative to 2011. Canada had 11 Fuel Cell patents (down 5) and Great Britain had one less than last year at 11. In single digits were Italy at 7 (up one), Denmark at 6 (up from zero the year before) and Switzerland which again had 3 Fuel Cell patents. Nine other countries had one Fuel Cell patent.

Looking at U.S. states in 2012, Michigan was on top after gaining one patent relative to 2011's total at 125. California was second with less than half that of the leader at 55 (up 8). Dropping by half again, Connecticut had 26 Fuel Cell patents (down 6 from 2011). Dropping further by half was New Jersey at 13 granted Fuel Cell patents matching 2011's total. Minnesota and Oregon tied at 11 while Florida, New York and Ohio had 10 Fuel Cell patents in 2012. Massachusetts rounded out the top ten with 9 Fuel Cell patents.

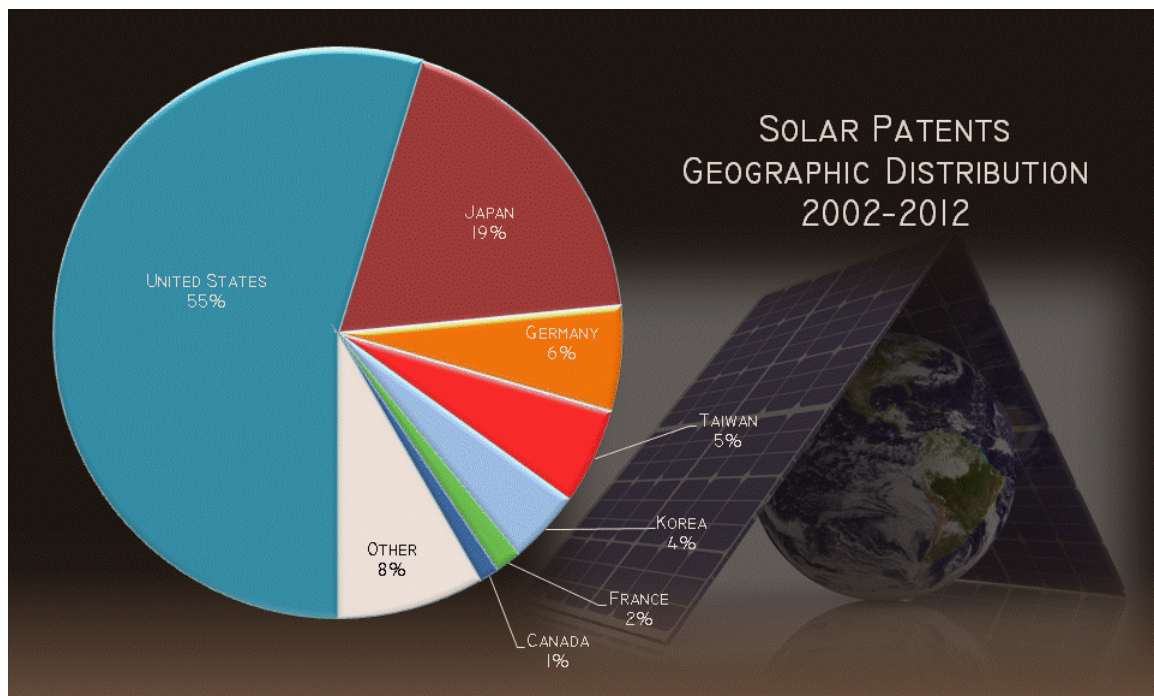
In Wind energy the U.S. remained ahead of the rest of the world in the number of U.S. patents granted since 2002 with 50 percent (down one percent), as depicted below largely on the strength of GE's Wind patents. Germany held steady at 17 percent due to Siemens and Aloys Wobben. Denmark held at 10 percent due to Vestas while Japan had 7 percent which was one more than last year. New York leads U.S. states with 46 percent of the U.S. Wind patents up one percent since last year, thanks to GE. California follows with 11 percent (down one percent) while Texas follows at 5 percent and Massachusetts, Illinois and Pennsylvania each have three percent.

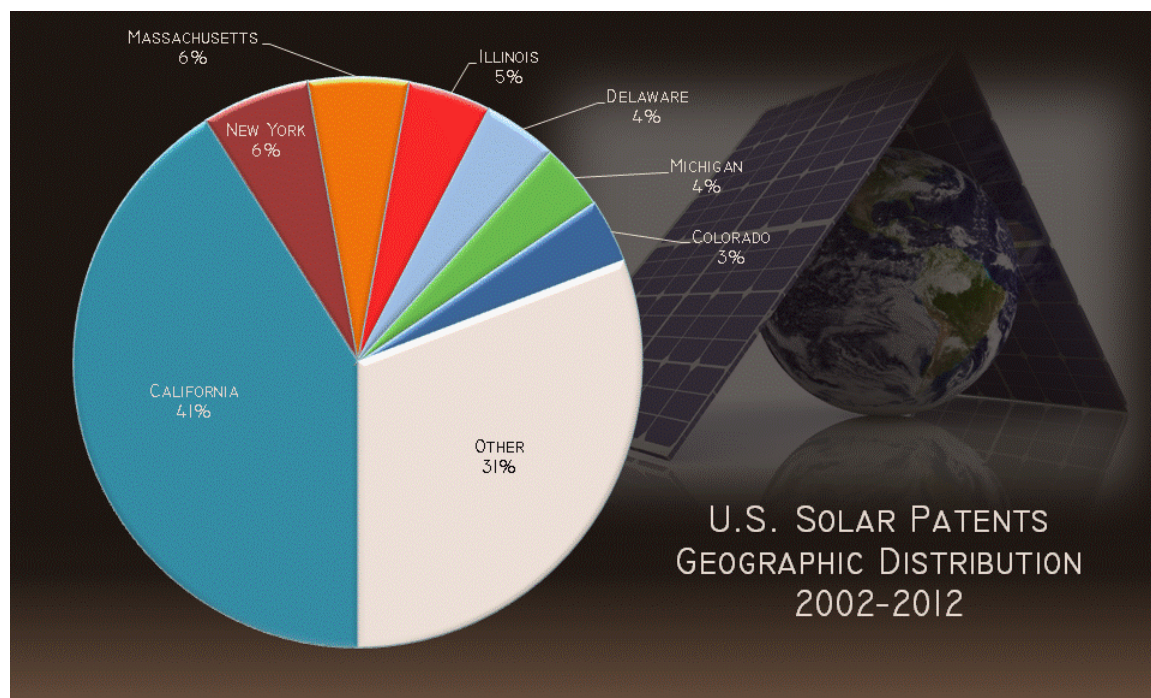


Looking at foreign grantees of U.S. Wind patents in 2012, Germany topped last year's winner, Denmark (63 in 2011) which had taken the crown from Germany the previous year. Germany jumped 42 patents to 95 while Denmark had 76, up 13 relative to 2011. Japan more than doubled its 2011 totals going from 29 to 70 Wind patents. Spain remained in the fourth spot as it was last year with 24 Wind patents (up 9) and China was up 10 Wind patents to a total of 12. Taiwan and Canada both had 9 Wind patents granted in 2012 while Austria and Great Britain had 5. Luxembourg and the Netherlands each had four Wind patents in 2012.

Despite GE's dominance of Wind patents mentioned above, there were more non-US holders of US Wind patents at 342 than US holders at 312. In the US, New York (157) continued to dominate the other states in 2012 gaining four patents over its 2011 totals. California's total (21) was down 4 and less than a seventh of New York's number of granted Wind patents. Pennsylvania moved into the third spot (15 patents) over Massachusetts relative to 2011 which dropped five places to eighth with 7 Wind patents. Texas (14) and Florida (11) followed. Colorado (9) edged out Massachusetts which tied with South Carolina. Ohio had 5 Wind patents while each of Connecticut, Illinois, Michigan, Minnesota, Nevada, Oregon, and Virginia had four. Eighteen other states had at least one Wind patent each.

The U.S. percentage of Solar patents since 2002 rose to 55 percent, up two percent over last year. Japan's share dropped three points to 19 percent, after dropping eight over the last two years, while Germany held steady at 6 percent. California's share of the U.S. total since 2002 held again at 41 percent while New York and Massachusetts had 6 percent. Illinois had five percent while Delaware and Michigan each had four percent of the US Solar patents granted since 2002.

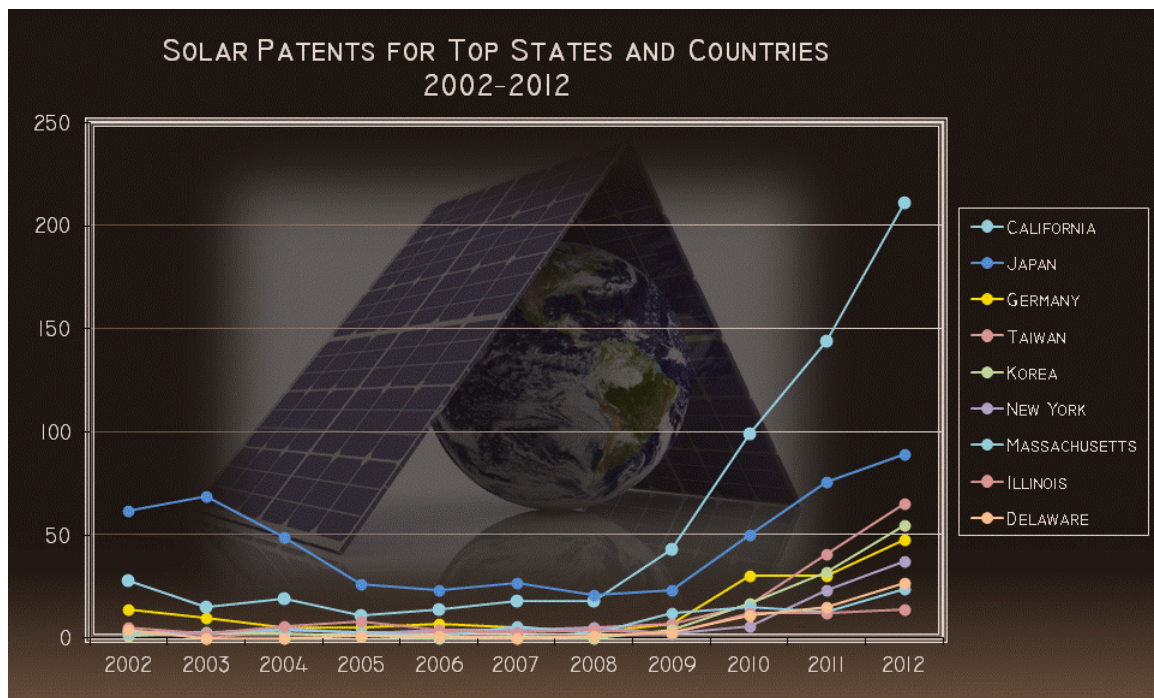




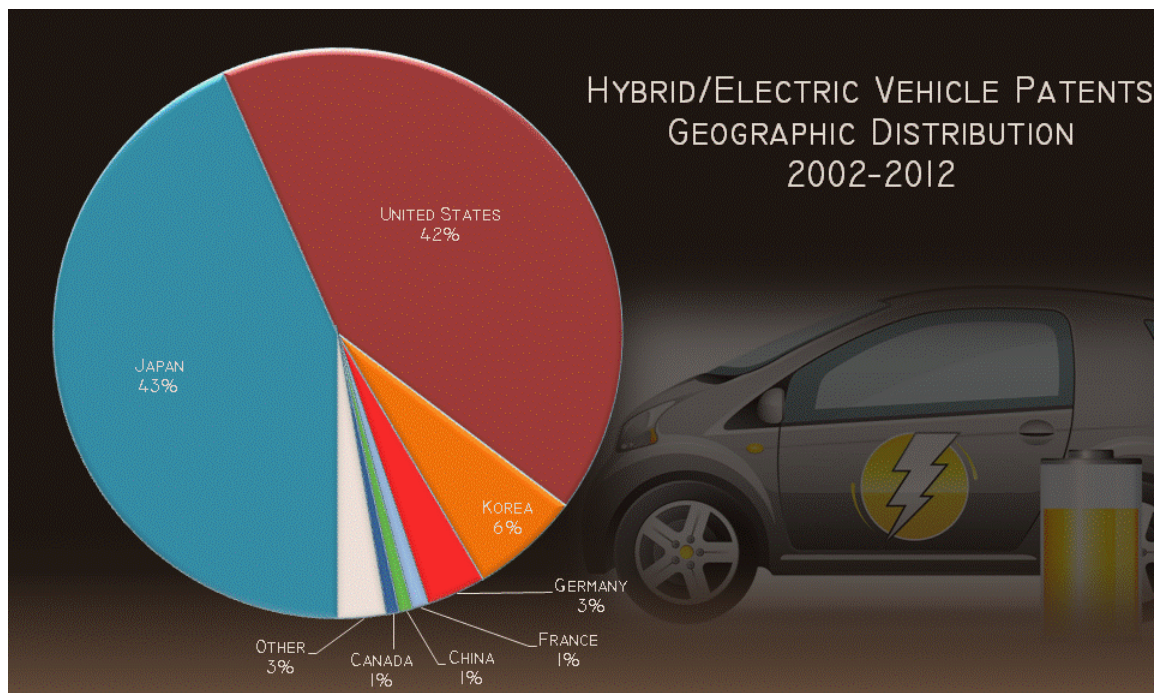
Looking at the 2012 totals for non-U.S. Holders of U.S. Solar patents, Japan was up 13 to 89 Solar patents and led Taiwan (65) which was in second place for the second year and after increasing 24 relative to 2011. Korea was up 33 patents yet still lagged Taiwan. Germany was in the fourth spot after jumping 18 patents compared to the year before and was followed by France and China with 12 Solar patents each. Spain (9) was next followed by three way tie between Hong Kong, Italy and the Netherlands at 8 granted U.S. Solar patents.

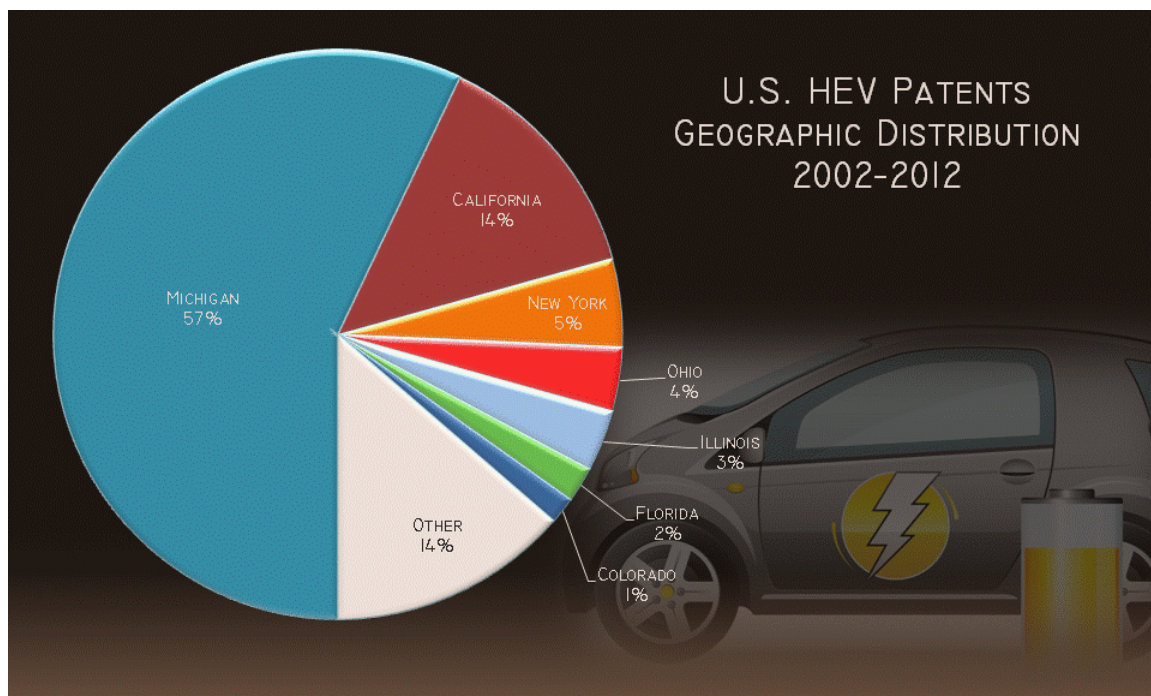
Relative to the U.S. States' showing in 2012, California (211) had over five times the number of patents of its nearest competitor, New York (37), with the nation's most populous state increasing an amazing 75 Solar patents relative to 2011. Delaware jumped 12 patents to 27 and Colorado rose 16 to 25. In fifth place, Massachusetts (24) added 11 relative to the year before. Texas went from 5 to 18 Solar patents in 2012. Arizona, Michigan and Ohio all had 16 Solar patents in 2012. New Mexico and Pennsylvania had 15 Solar patents to round out the top 10. Twenty other states had at least one Solar patent.

As depicted in the line chart below, California also had more Solar patents than any other country and has added patents in Solar technologies since 2010 at a rate unparalleled by any state or country. Japan's totals in this time period outshine any of the others. Taiwan, Korea, Germany, and New York also trend sharply upward since 2010.



Japan led the other U.S. Hybrid/Electric Vehicle patent holders since 2002 with 43 percent of the granted U.S. patents while dropping two points from last year's results (and four points from the year before), as depicted below. The U.S. held steady at 42 percent of the granted U.S. Patents since 2002, up 3 percent. Korea rose slightly from 5 to 6 percent while Germany held at 3 percent. Michigan fell slightly to U.S. states since 2002 with 57 percent of the U.S. share of the granted U.S. patents in this area. California jumped a point to 14 while New York led Ohio and by one percent, 5 to 4. Colorado, Illinois and Florida each have three percent or less.

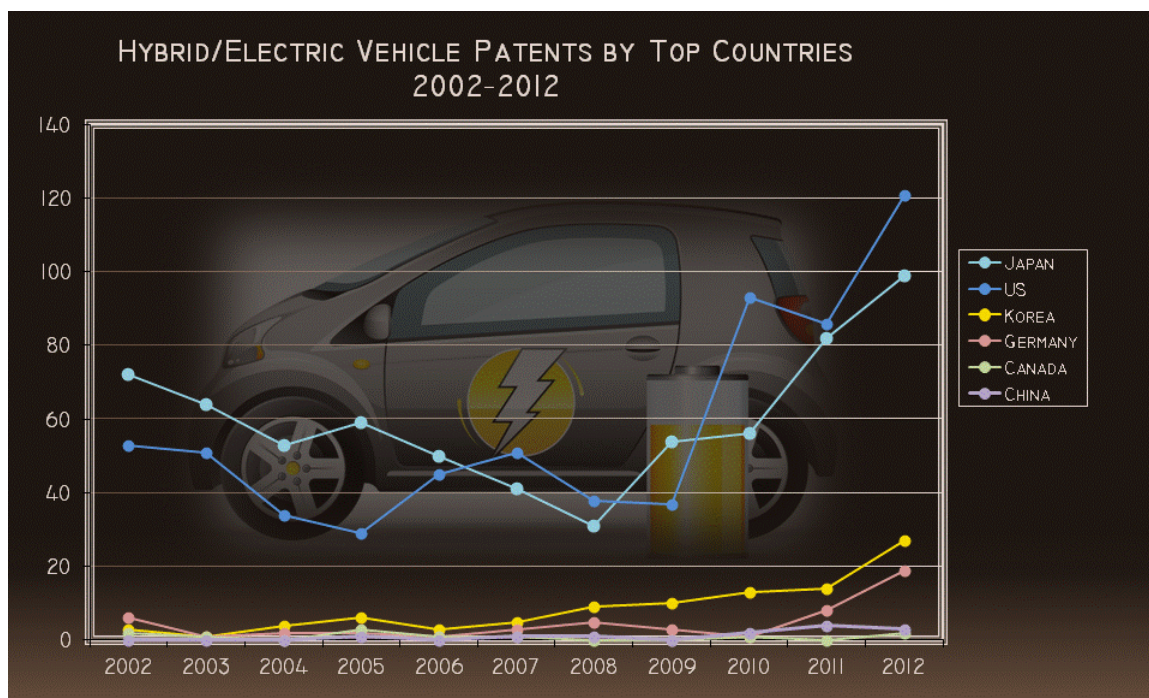




Looking at granted U.S. Hybrid/Electric Vehicle patents in 2012 only, Japan led the non-U.S. Patents holders by a wide margin gaining 17 patents to arrive at 99, which was almost four times runner up Korea which rose 13 to arrive at 27 hybrid/electric vehicle patents in 2012. Germany was up 11 to 19 patents in this area and the rest of the countries with Hybrid/Electric patents have 4 or less including France with 4 and a four way tie for three by China, Sweden, Switzerland and Taiwan. Canada, the Czech Republic, Denmark and Italy each had one.

Relative to Hybrid/Electric Vehicle patents in 2012 for the U.S. States, Michigan continued to dominate the rankings with 54 patents up from 39 last year while runner up California held steady at 20 - the same as 2011. At less than half of California, New York again had 9 patents in 2012 and Illinois dropped one to 5 Hybrid/Electric Vehicle patents. Florida, Washington, and Georgia all had 4 Hybrid/Electric Vehicle patents in 2012 while five states had two patents and 8 states had one patent in the Hybrid/Electric Vehicle space.

Looking at the line chart below, the US led Japan for the second straight year while US entities (121) had fewer US Hybrid/Electric Vehicle patents than the rest of the world combined.



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