tIPs
Intellectual Property Insights

October 2021

SOLAR POWER
A Special Report

SUCCESSFULLY NAVIGATING THE PATENT LANDSCAPE

KLEIMAN

SUMMARY

Projected $562 Billion In U.S. Solar Power Growth

Navigating A Crowded U.S. Patent Landscape To Achieve Victory & Avoid Defeat

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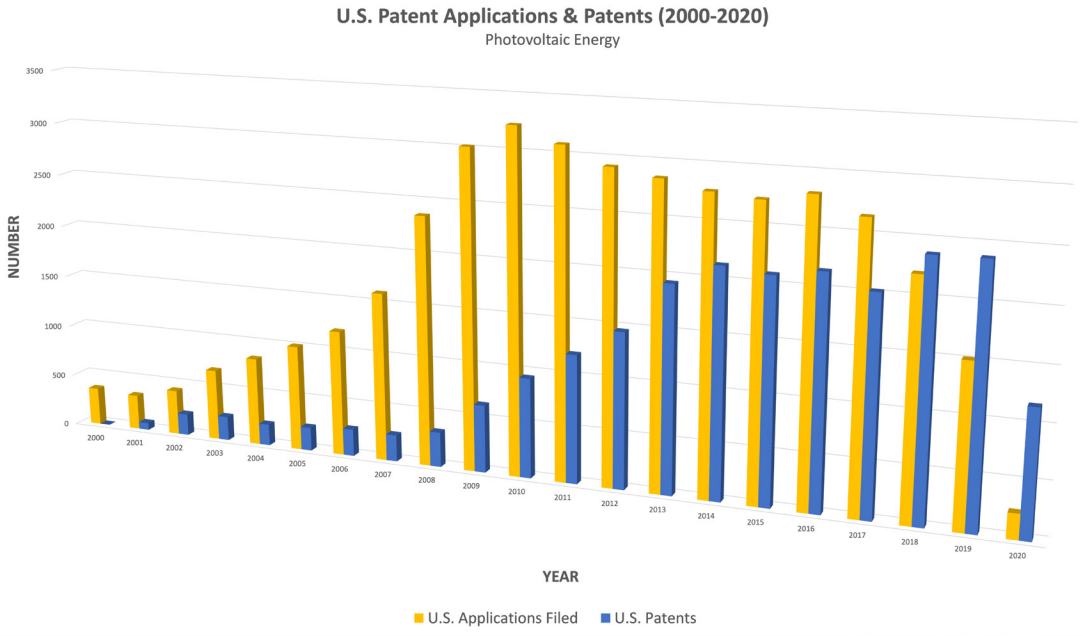
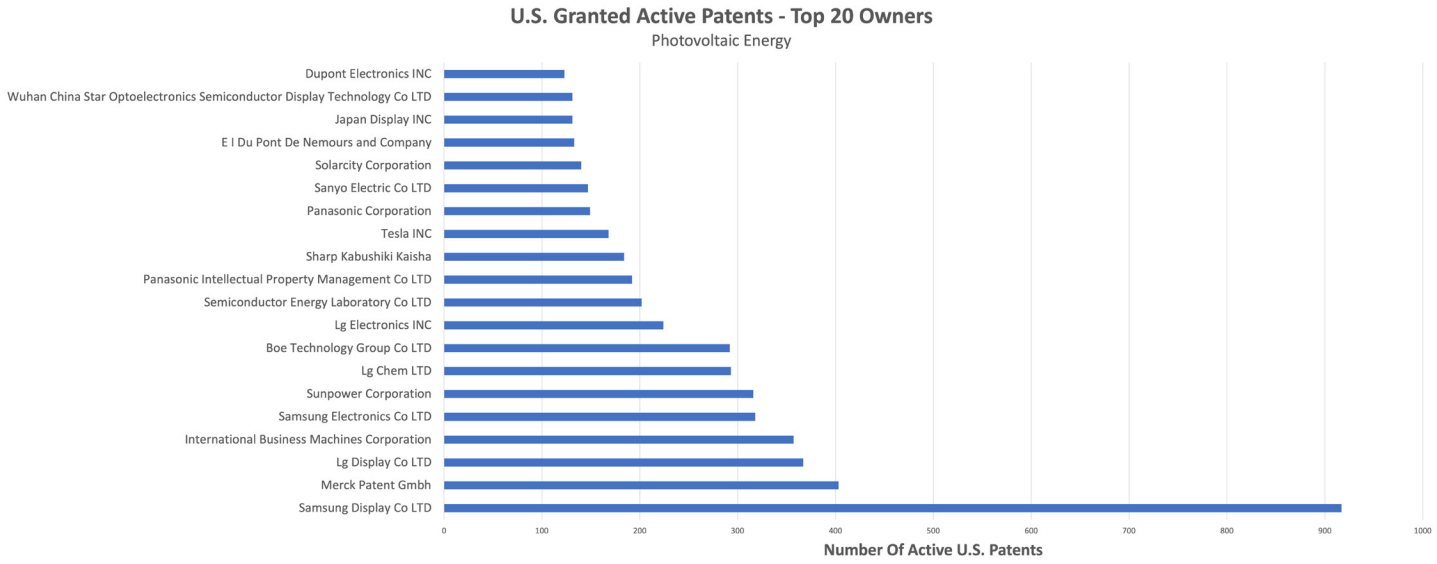
Recently the U.S. Department of Energy projected that electricity from solar power in the U.S. would increase from 3% presently to possibly as much as 37% by 2035 and as much as 44% by 2050[1]. With $562 billion in solar power infrastructure investment projected **this is an exciting opportunity for businesses in the solar power industry**. However, as great as the opportunities which lie ahead are, there are obstacles and dangers a solar power business will need to successfully navigate. Among these are the many unexpired U.S. patents for the inventions used in modern solar power systems. There are of course many technologies which go into a modern solar power system, but photovoltaic (PV) technology is at the core of every system.

While the basic solid state PV cell (i.e., solar cell) dates to 1954, there has been much innovation in PV technology since then, and more is expected. For solar power businesses the patent landscape for PV technologies must be successfully navigated. Presented herein is an overview of the most prominent PV energy technologies and their U.S. patent landscapes[2].

In general the patent landscape for PV energy technologies is a fairly crowded one: **There are nearly 18,000 unexpired U.S. patents, and at least another 3,000 pending U.S. patent applications, for photovoltaic energy technologies.**

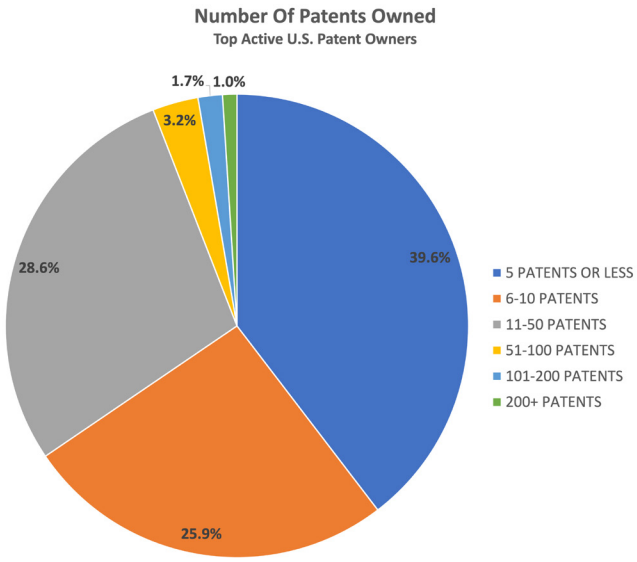




Each unexpired U.S. patent gives its owner a set of powerful exclusive legal rights within the U.S. to make, use, offer to sell, sell, and import the invention claimed in the patent. A business which infringes upon the legal exclusive legal rights of the patent owner can be sued for patent infringement, whether they knew about the patent or not.

Aside from the enormous expense of patent litigation, liability can mean payment of steep damages (no less than a reasonable royalty and going as far back as six years). It can also mean paying the patent owner's attorney fees and costs, and being court ordered to stop making, using, importing, or selling the invention. In sum, a patent infringement lawsuit has the potential to ruin a small or medium sized business enterprise, and even some larger ones.

Litigation involving PV energy U.S. patents has historically been low, but since 2016 has experienced a dramatic 203% average annual growth. This upward trend in litigation may continue with the expected increase in U.S. solar power projected in upcoming years.



U.S. PATENT APPLICATIONS[2] - Photovoltaic Energy	
Total U.S. Applications Filed 2015-2019	11927
Average Annual Growth (2015-2019)	-10%
Number Currently Pending In The USPTO	3166
U.S. PATENTS[2] - Photovoltaic Energy	
Unexpired Patents	17870
Number Granted (2015-2020)	11050
Avg. Annual Growth Rate (2015-2020)	-7%
Percentage Held By Top 1% Of Owners	21%
Number of Patents Litigated	72

While crowded and growing, the PV technology patent landscape has shown a recent decline in the annual number of U.S. patent applications being filed. This could be an indication that the rate of innovation in PV technology is slowing. However, another possibility is that a decreasing trend in annual patent application filings simply reflects an increased reliance recently on trade secret protection if a shift has occurred in the nature of the PV energy innovations (e.g., secret manufacturing processes).

This highlights the fact that patent infringement is not the only IP danger a solar power business must navigate on the way to success. For example, there are currently **more than 5,000 active registered U.S. trademarks for solar panels or modules**. Copyright protection also exists on the software, media, and other works of authorship used in connection with commercial solar power businesses. Trade secrets on confidential business information and technologies (e.g., manufacturing processes) must also be properly managed, particularly in the context of employees moving between employers.

On the flip-side of the IP infringement dangers there are opportunities: Being the owner of intellecual property rights offers potentially lucrative opportunities for increased market share, profit margins, and/or beneficial licensing deals. **Studies have estimated that today 80% or more of the value of a company is often found in the intangible assets of the business such as its patents, trademarks, copyrights, trade secrets, and goodwill.** Competitors will gladly take sales and force prices down if given the opportunity, which is often exactly what happens when important IP rights are not properly secured.

While the focus of this special report is the PV technologies at the core of every solar power system, the fundamental caveat of being situationally aware of the IP rights landscape applies to all technologies in a modern solar power system.

WATCHING YOUR STEP

THE IP RIGHTS AUDIT

Achieving IP Situational Awareness

Only a fool would expect to safely navigate a minefield while blindfolded. It is no different when it comes to businesses safely navigating the intellectual property (IP) rights landscape that they operate in. Ignorance is not a defense to a claim of patent infringement.

Wise business leaders seek situational awareness of the IP rights landscape they are operating in: Both to secure valuable IP rights for the business itself, and to avoid very expensive legal disputes and liability for claims of IP rights infringement.

Performing a periodic IP rights audit is a best practice for achieving such situational awareness. For readers unfamiliar with the term, an IP rights audit is a tool that identifies the potential IP rights assets and liabilities of a business enterprise. An IP rights audit can be used to create a map of the IP rights landscape for a particular business. Such a map can be invaluable to the business in finding success.

Performing an IP rights audit is one of the best, most important, and relatively affordable investments a business can make. This is particularly true given the crowded IP rights landscape for modern products and services (i.e., there are a lot of "mines" out there). If your business hasn't recently performed an audit, and mapped its IP rights landscape, now is the time.

PATENT LANDSCAPE

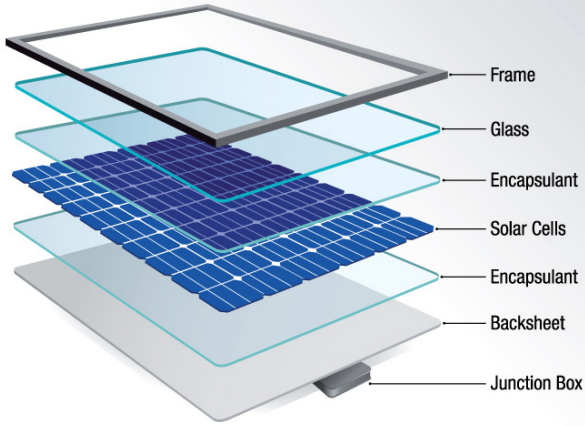
Photovoltaic Energy Technologies

KLEIMAN

PHOTOVOLTAIC TECHNOLOGY

Photovoltaic (PV) materials and devices convert sunlight into electrical energy. A single PV device is known as a cell. An individual PV cell is usually small, typically producing about 1 or 2 watts of power. These cells are made of different semiconductor materials and are often less than the thickness of four human hairs. In order to withstand the outdoors for many years, cells are sandwiched between protective materials in a combination of glass and/or plastics.[3]

To boost the power output of PV cells, they are connected in chains to form larger units known as modules or panels. When modules are connected, they make a solar system, or installation. A typical residential rooftop solar system has about 30 modules. [3]



PARTS OF A SOLAR PANEL

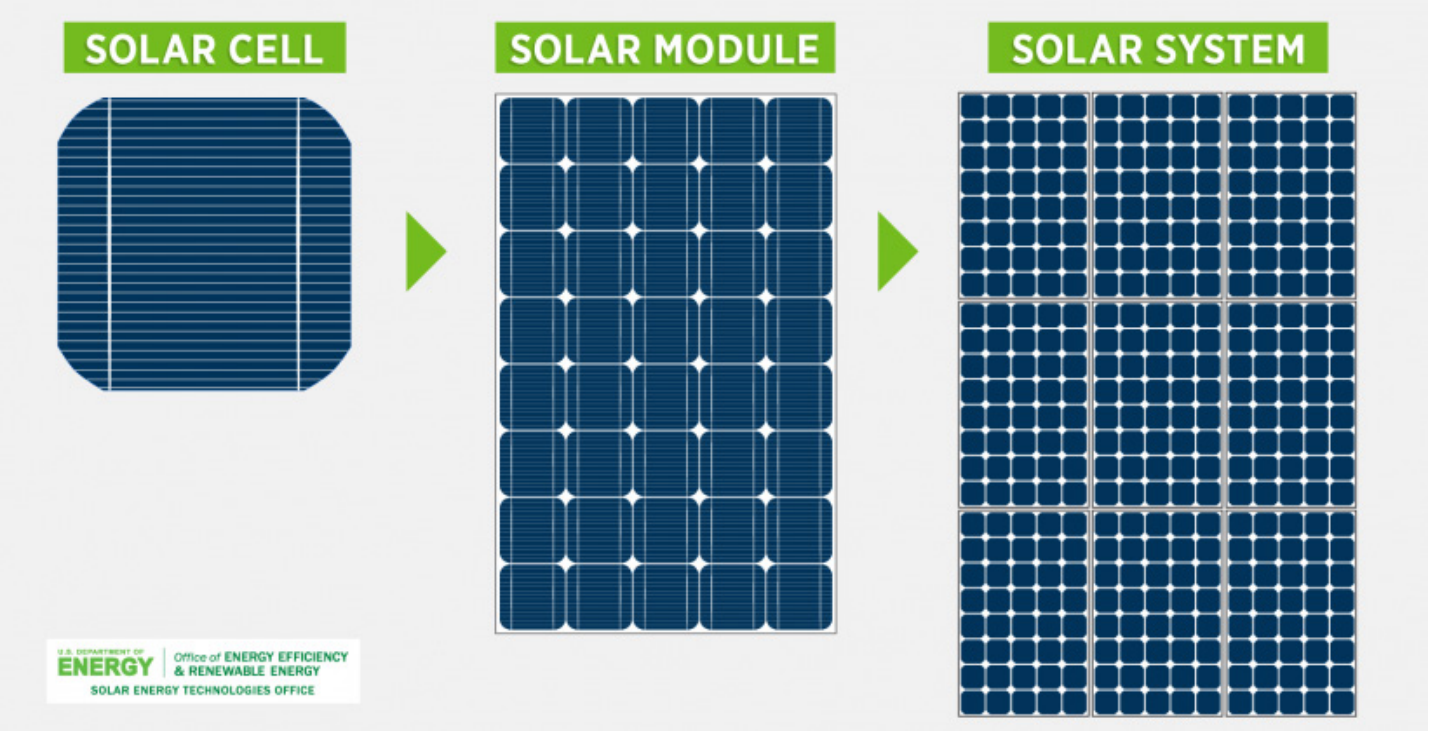


Image Source: U.S. Department of Energy

U.S. PATENT LANDSCAPE
Photovoltaic Energy - Silicon

Crystalline silicon PV cells are the most common solar cells used in commercially available solar panels. Crystalline silicon PV cells have laboratory energy conversion efficiencies over 25% for single-crystal cells and over 20% for multicrystalline cells. However, industrially produced solar modules currently achieve efficiencies ranging from 18%-22% under standard test conditions[3].

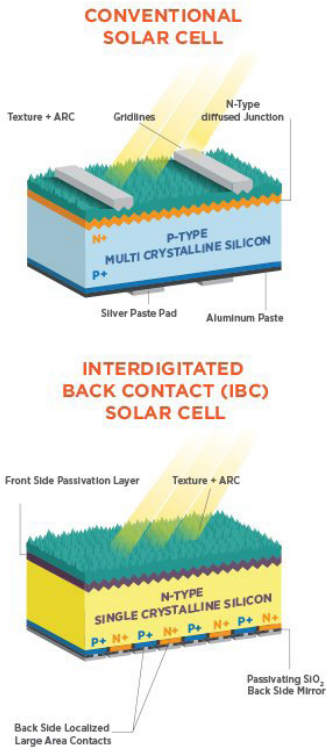
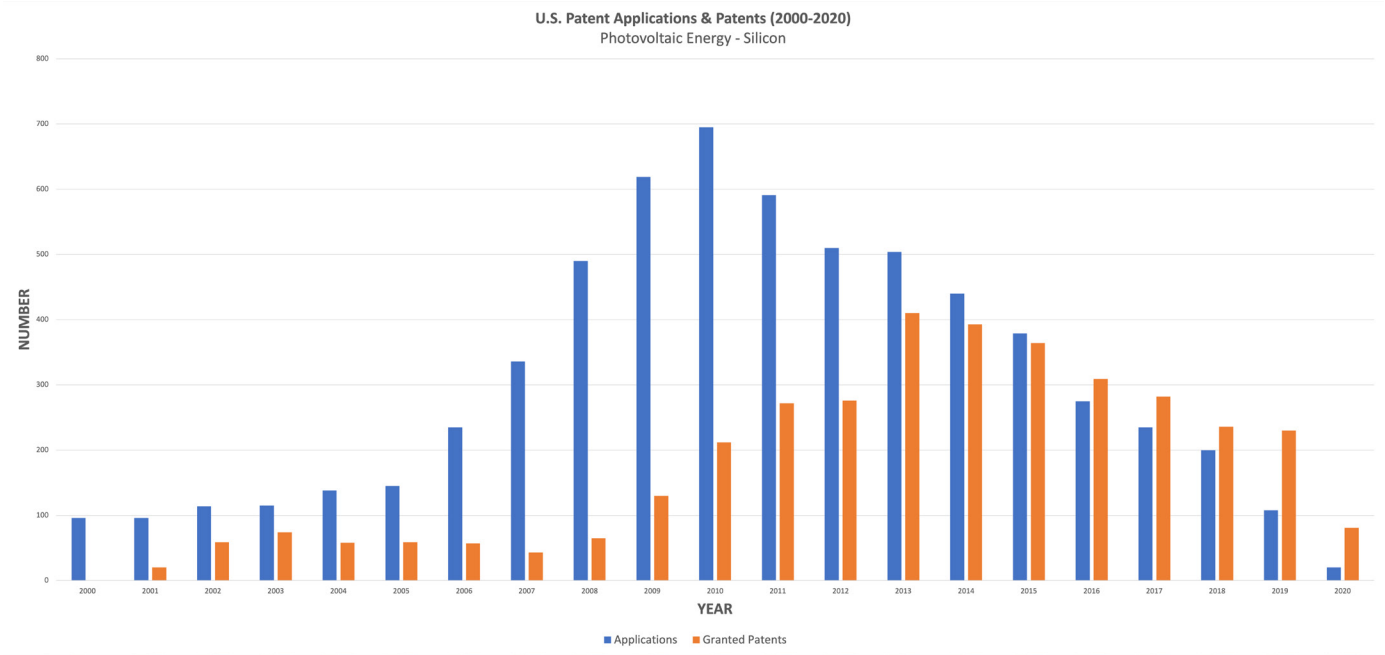


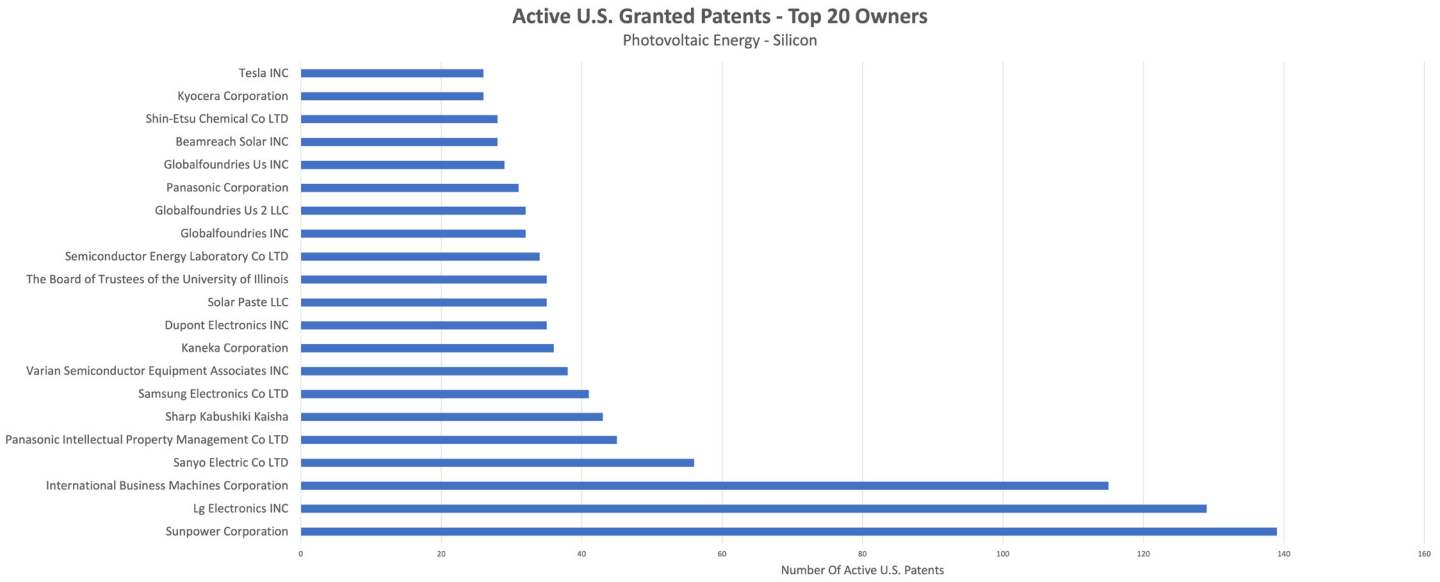
Image Source: U.S. Department of Energy

Typical crystalline silicon solar cells are produced from monocrystalline (single-crystal) silicon or multicrystalline silicon. Monocrystalline cells are produced from pseudo-square silicon wafers, substrates cut from boules grown by the Czochralski process, the float-zone technique, ribbon growth, or other emerging techniques. Multicrystalline silicon solar cells are traditionally made from square silicon substrates cut from ingots cast in quartz crucibles[3].

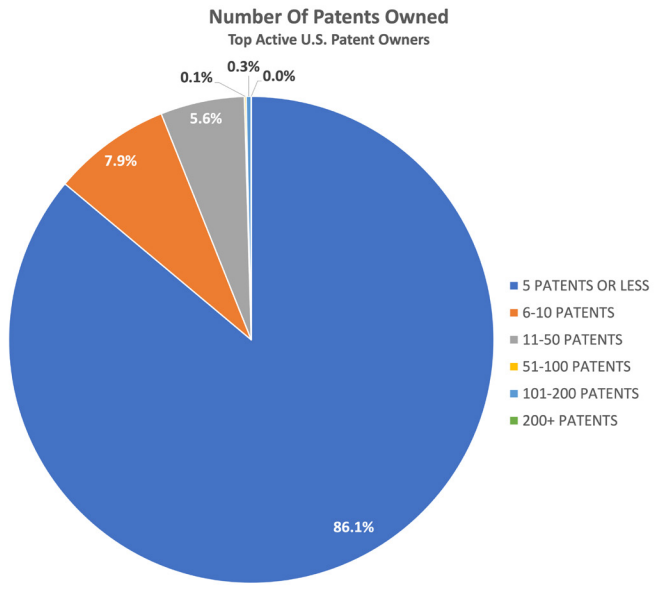
To reduce the amount of light reflected by the solar cell and therefore not used to generate current an antireflective coating (ARC), often titanium dioxide (TiO2) or silicon nitride (SiN), is deposited on the silicon surface. To increase light trapping and absorption, the top of the solar cell can be textured with micrometer-sized pyramidal structures, formed by a chemical etch process[3].

To create a p-n junction, typically a phosphorus-doped n+ region is created on top of a boron-doped p-type silicon substrate. A metal electrode, such as aluminum, forms the back contact, whereas the front contact is most often formed using screen-printed silver paste applied on the top of the ARC layer[3].





U.S. patent application activity for silicon solar cell technology generally experienced tremendous growth from 2000-2010. From 2010-2019 however there has been an average annual decline of 15% in the number of applications filed for silicon solar cell inventions. The number of U.S. patents granted has experienced a 21% rate of decline from 2015-2020. Approximately 26% of unexpired silicon crystal solar cell patents are owned by the top 1% of owners for such patents. However, as shown in the accompanying pie chart, 94% of the top owners own 10 or fewer of such U.S. patents.



U.S. PATENT APPLICATIONS[2] - Photovoltaic Energy	
Total U.S. Applications Filed 2015-2019	1197
Average Annual Growth (2015-2019)	-23%
Number Currently Pending In The USPTO	235
USPTO Technology Center (TC)	1700
USPTO Technology Group (TG)	1720
Avg. TC Time To First Office Action (Months)	16.2
Avg. TC Application Pendency (Months)	26.6
Avg. TC Application Grant Rate (3 Year)	61%
Avg. TG Application Grant Rate (3 Year)	57%
Avg. TC Pendency Of An Appeal (Months)	12.7
Reversal Rate For TC On Appeal	42%
U.S. PATENTS[2] - Photovoltaic Energy	
Unexpired Patents	2591
Number Granted (2015-2020)	1502
Avg. Annual Growth Rate (2015-2020)	-21%
Percentage Held By Top 1% Of Owners	26%

U.S. PATENT LANDSCAPE
Photovoltaic Energy - CdTe

CdTe solar cells are the second most common photovoltaic (PV) technology in the world marketplace after crystalline silicon, currently representing 5% of the world market. CdTe thin-film solar cells can be manufactured quickly and inexpensively, providing an alternative to conventional silicon-based technologies. The record efficiency for a laboratory CdTe solar cell is 22.1% by First Solar. First Solar also reported its average commercial module efficiency to be approximately 18% at the end of 2020[3].

The benefits of CdTe thin-film solar cells include:

1. High absorption: Cadmium telluride is a direct-bandgap material with bandgap energy that can be tuned from 1.4 to 1.5 (eV), which is nearly optimal for converting sunlight into electricity using a single junction.
2. Low-cost manufacturing: Cadmium telluride solar cells use high throughput manufacturing methods to produce completed modules from input materials in a matter of hours.

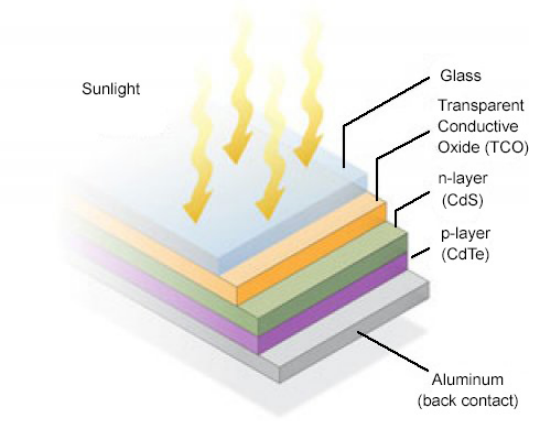
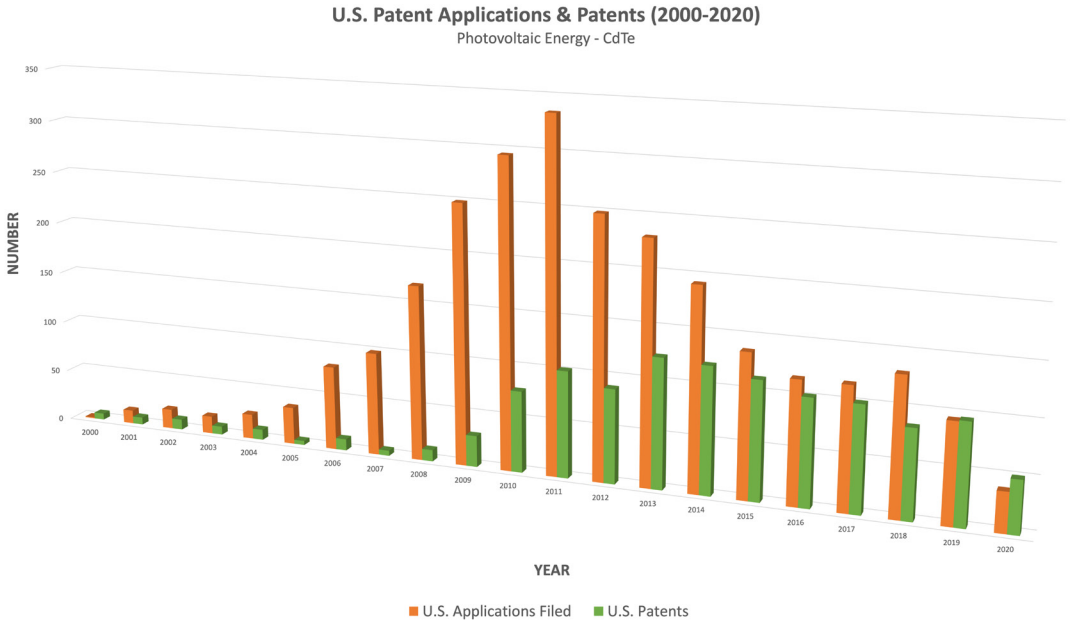
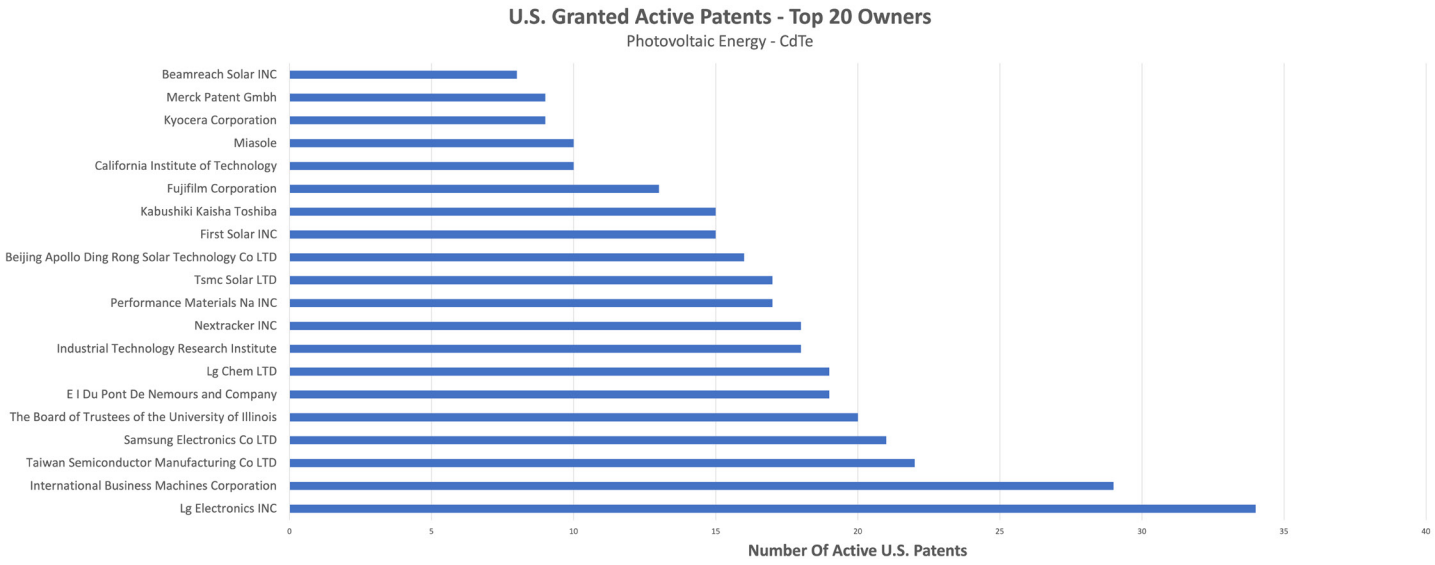


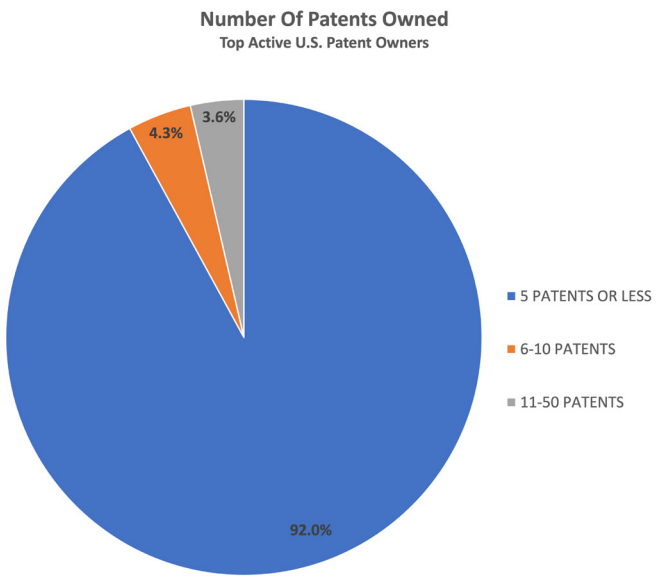
Image Source: U.S. Department of Energy

Current research seek higher cell efficiencies by increasing crystal quality, improving doping control, and increasing the minority carrier lifetime. Manufacturers are also working to improve the reuse and recycling of materials as a way to mitigate concerns on toxicity and materials scarcity[3].





U.S. patent application activity for CdTe solar cell technology generally experienced tremendous growth from 2000-2011. From 2012-2019 however there has been an average annual decline of 14% in the number of applications filed for CdTe solar cell inventions. The number of U.S. patents granted has experienced a 12% rate of decline from 2015-2020. Approximately 13% of unexpired CdTe solar cell patents are owned by the top 1% of owners for such patents. However, as shown in the accompanying pie chart, 96% of the top owners own 10 or fewer of such U.S. patents.



U.S. PATENT APPLICATIONS[2] - Photovoltaic Energy	
Total U.S. Applications Filed 2015-2019	597
Average Annual Growth (2015-2019)	-12%
Number Currently Pending In The USPTO	143
USPTO Technology Center (TC)	1700
USPTO Technology Group (TG)	1720
Avg. TC Time To First Office Action (Months)	16.2
Avg. TC Application Pendency (Months)	26.6
Avg. TC Application Grant Rate (3 Year)	61%
Avg. TG Application Grant Rate (3 Year)	57%
Avg. TC Pendency Of An Appeal (Months)	12.7
Reversal Rate For TC On Appeal	42%
U.S. PATENTS[2] - Photovoltaic Energy	
Unexpired Patents	823
Number Granted (2015-2020)	497
Avg. Annual Growth Rate (2015-2020)	-12%
Percentage Held By Top 1% Of Owners	13%

U.S. PATENT LANDSCAPE
Photovoltaic Energy - CIGS

Since its initial development, copper indium diselenide (CuInSe2) thin-film technology has been considered promising for solar cells because of its favorable electronic and optical properties. It was later found that by substituting gallium (Ga) for indium (In), the bandgap can be increased from about 1.04 electron-volts (eV) for copper indium diselenide (CIS) films to about 1.68 eV for copper gallium diselenide (CGS) films. Optimal devices have been fabricated with only a partial substitution of Ga for In, leading to a substantial increase in overall efficiency and more optimal bandgap. These solar cells are commonly known as a copper indium gallium diselenide [Cu(InxGa1-x)Se2], or CIGS, cells[3].

Although laboratory-scale cell efficiencies have exceeded 20%, commercial CIGS modules typically have efficiencies between 12% and 14%. The benefits of CIGS solar cells include:

1. High absorption: This direct-bandgap material can absorb a significant portion of the solar spectrum, enabling it to achieve the highest efficiency of any thin-film technology.
2. Tandem design: A tunable bandgap allows the possibility of tandem CIGS devices.
3. Protective buffer layer: The grain boundaries form an inherent buffer layer, preventing surface recombination and allowing for films with grain sizes of less than 1 micrometer to be used in device fabrication[3].

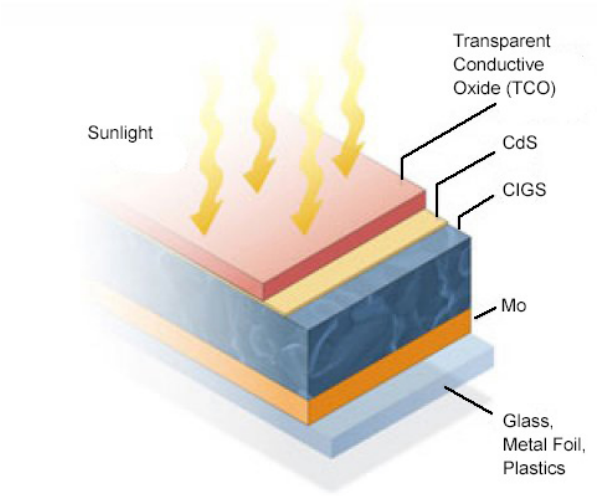
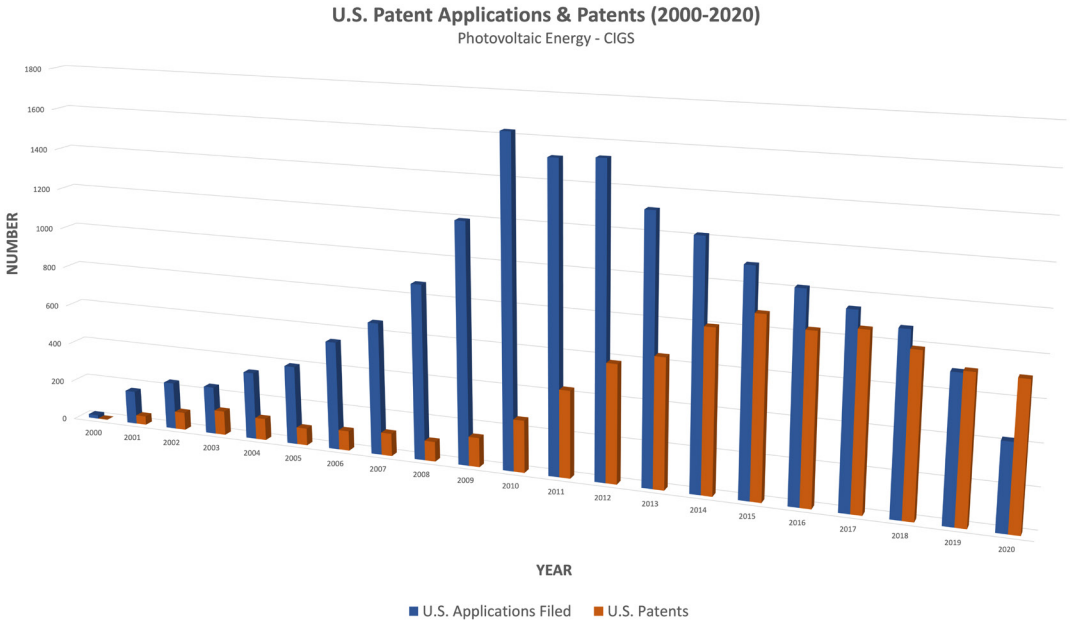
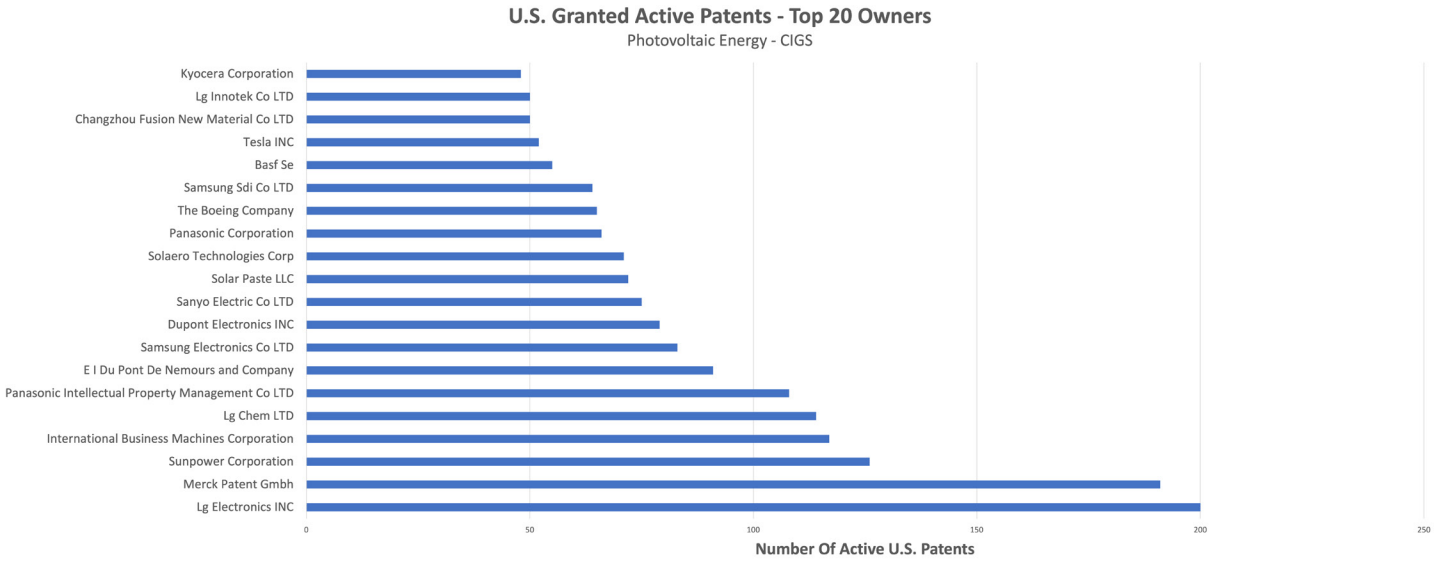
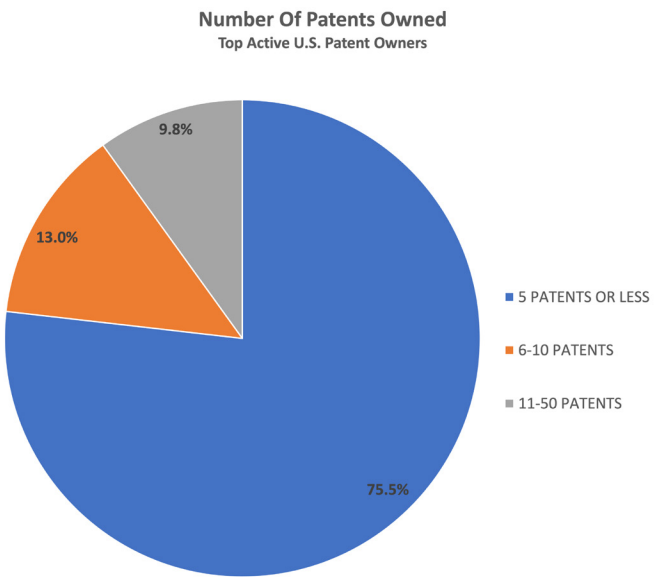


Image Source: U.S. Department of Energy





U.S. patent application activity for CIGS solar cell technology generally experienced tremendous growth from 2000-2010. From 2011-2019 however there has been an average annual decline of 9% in the number of applications filed for CIGS solar cell inventions. The number of U.S. patents granted has experienced a 4% rate of decline from 2015-2020. Approximately 18% of unexpired CIGS solar cell patents are owned by the top 1% of owners for such patents. However, as shown in the accompanying pie chart, 85% of the top owners own 10 or fewer of such U.S. patents.



U.S. PATENT APPLICATIONS[2] - Photovoltaic Energy	
Total U.S. Applications Filed 2015-2019	4646
Average Annual Growth (2015-2019)	-10%
Number Currently Pending In The USPTO	1096
USPTO Technology Center (TC)	1700
USPTO Technology Group (TG)	1720
Avg. TC Time To First Office Action (Months)	16.2
Avg. TC Application Pendency (Months)	26.6
Avg. TC Application Grant Rate (3 Year)	61%
Avg. TG Application Grant Rate (3 Year)	57%
Avg. TC Pendency Of An Appeal (Months)	12.7
Reversal Rate For TC On Appeal	42%
U.S. PATENTS[2] - Photovoltaic Energy	
Unexpired Patents	6581
Number Granted (2015-2020)	4080
Avg. Annual Growth Rate (2015-2020)	-4%
Percentage Held By Top 1% Of Owners	18%

U.S. PATENT LANDSCAPE
Photovoltaic Energy - Multijunction III-V

High-efficiency multijunction devices use multiple bandgaps, or junctions, that are tuned to absorb a specific region of the solar spectrum to create solar cells having record efficiencies over 45%. Multijunction devices use a high-bandgap top cell to absorb high-energy photons while allowing the lower-energy photons to pass through. A material with a slightly lower bandgap is then placed below the high-bandgap junction to absorb photons with slightly less energy (longer wavelengths). Typical multijunction cells use two or more absorbing junctions, and the theoretical maximum efficiency increases with the number of junctions[3].

Early research into multijunction devices leveraged the properties of semiconductors comprised from elements in the III and V columns of the Periodic table, such as gallium indium phosphate (GaInP), gallium indium arsenide (GaInAs), and gallium arsenide (GaAs). The architecture can also be transferred to other solar cell technologies, and multijunction cells made from CIGS, CdSe, silicon, organic molecules, and other materials are being investigated[3].

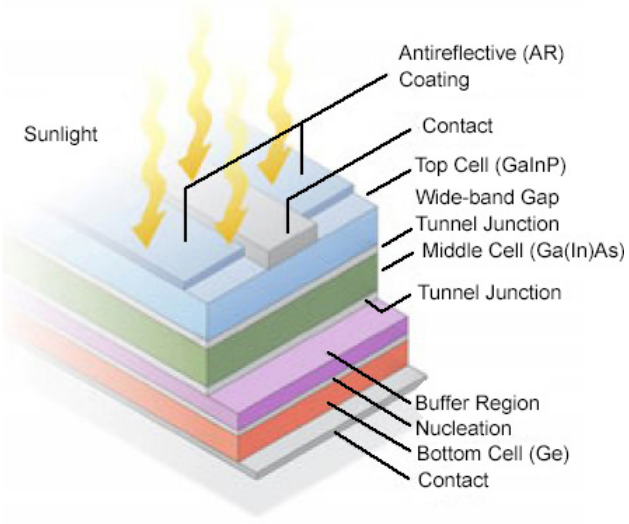
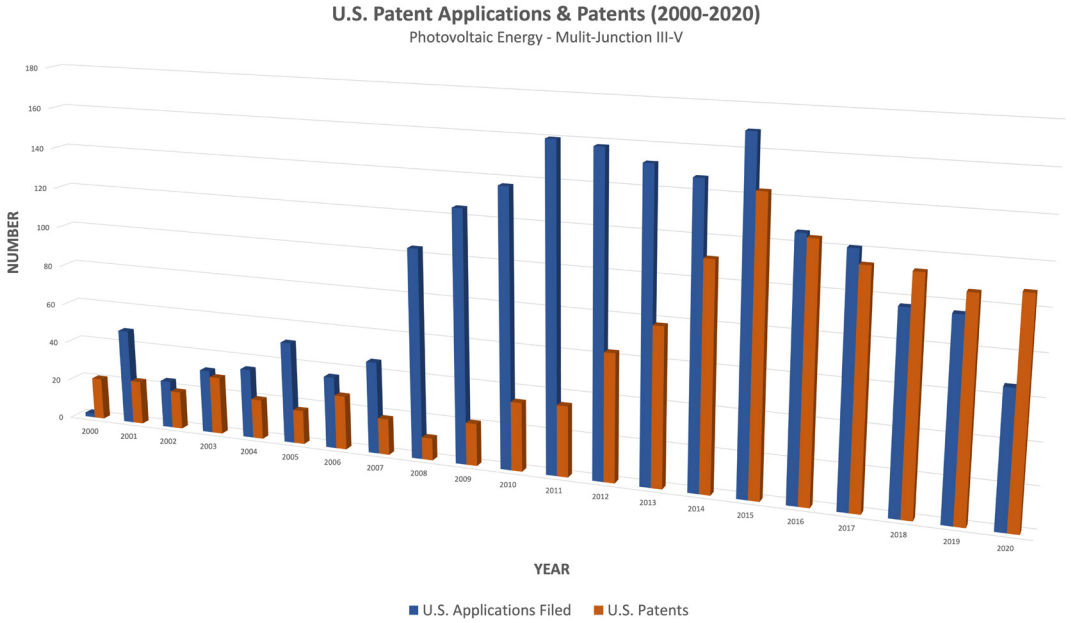
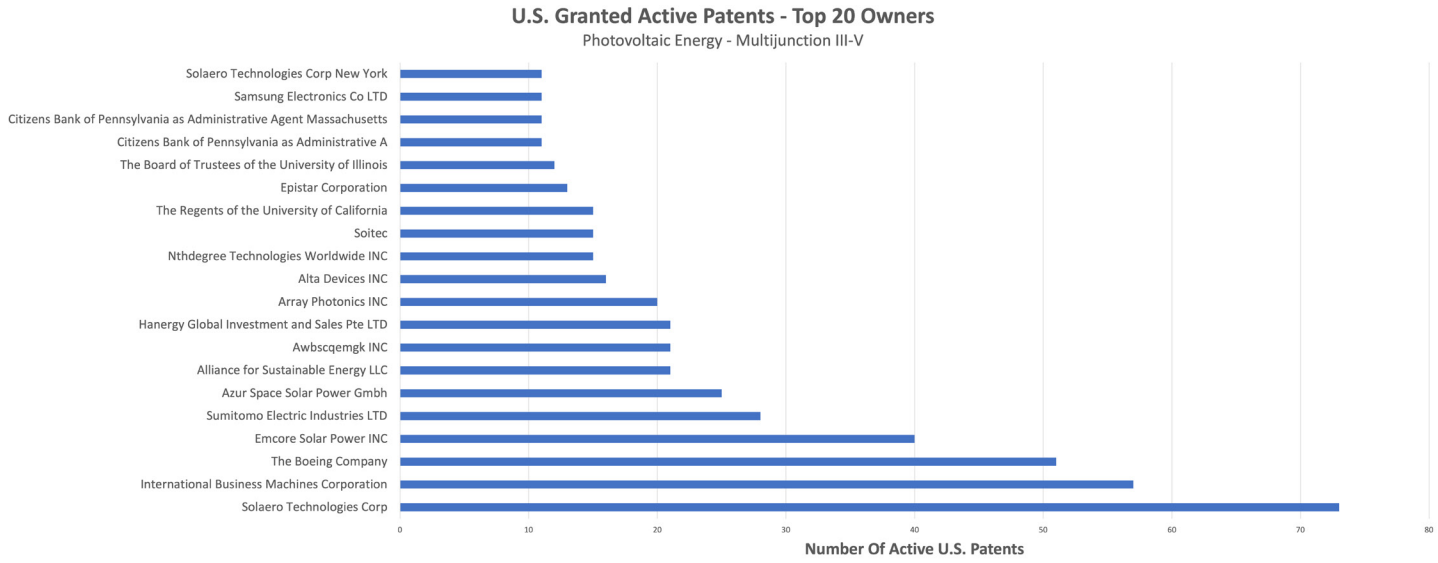


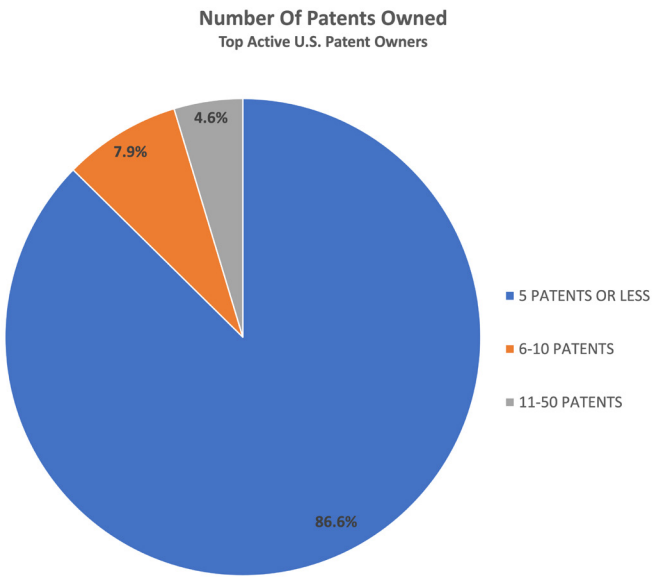
Image Source: U.S. Department of Energy

Although multijunction III-V cells have higher efficiencies than competing technologies, such solar cells are considerably more costly because of current fabrication techniques and materials. Therefore, active research efforts are directed at lowering the cost of electricity generated by these solar cells through approaches such as developing new substrate materials, absorber materials, and fabrication techniques; increasing efficiency; and extending the multijunction concept to other PV technologies[3].





U.S. patent application activity for multijunction III-V solar cell technology generally experienced tremendous growth from 2000-2015. From 2015-2019 however there has been an average annual decline of 7% in the number of applications filed for multijunction III-V solar cell inventions. The number of U.S. patents granted has experienced a 5% rate of decline from 2015-2020. Approximately 22% of unexpired multijunction III-V solar cell patents are owned by the top 1% of owners for such patents. However, as shown in the accompanying pie chart, 94% of the top owners own 10 or fewer of such U.S. patents.



U.S. PATENT APPLICATIONS[2] - Photovoltaic Energy	
Total U.S. Applications Filed 2015-2019	609
Average Annual Growth (2015-2019)	-7%
Number Currently Pending In The USPTO	112
USPTO Technology Center (TC)	1700
USPTO Technology Group (TG)	1720
Avg. TC Time To First Office Action (Months)	16.2
Avg. TC Application Pendency (Months)	26.6
Avg. TC Application Grant Rate (3 Year)	61%
Avg. TG Application Grant Rate (3 Year)	57%
Avg. TC Pendency Of An Appeal (Months)	12.7
Reversal Rate For TC On Appeal	42%
U.S. PATENTS[2] - Photovoltaic Energy	
Unexpired Patents	1023
Number Granted (2015-2020)	600
Avg. Annual Growth Rate (2015-2020)	-5%
Percentage Held By Top 1% Of Owners	22%

U.S. PATENT LANDSCAPE
Photovoltaic Energy - Organics

Organic photovoltaic (OPV) solar cells aim to provide an Earth-abundant and low-energy-production photovoltaic (PV) solution. This technology also has the theoretical potential to provide electricity at a lower cost than early generation solar technologies. Because various absorbers can be used to create colored or transparent OPV devices, this technology is particularly appealing to the building-integrated PV market. Organic photovoltaics have achieved efficiencies near 11%, but efficiency limitations as well as long-term reliability remain significant barriers[3].

The low efficiencies of OPV cells are related to their small exciton diffusion lengths and low carrier mobilities. These two characteristics ultimately result in the use of thin active layers that affect overall device performance. Furthermore, the operational lifetime of OPV modules remains significantly lower than for inorganic devices. Current research focuses on increasing device efficiency and lifetime[3].

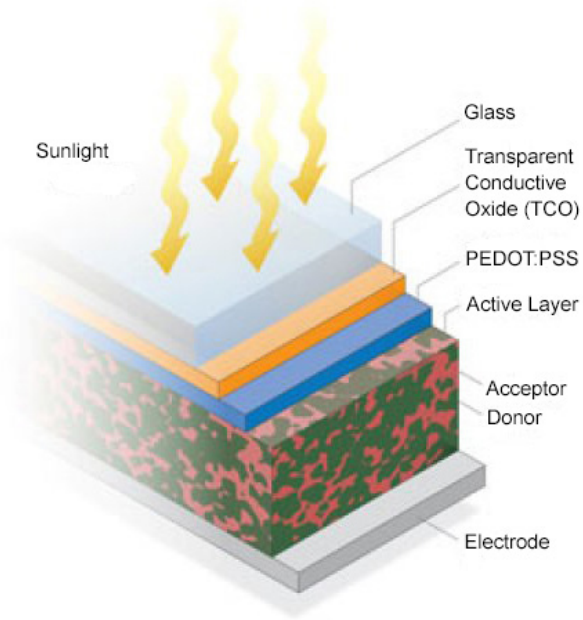
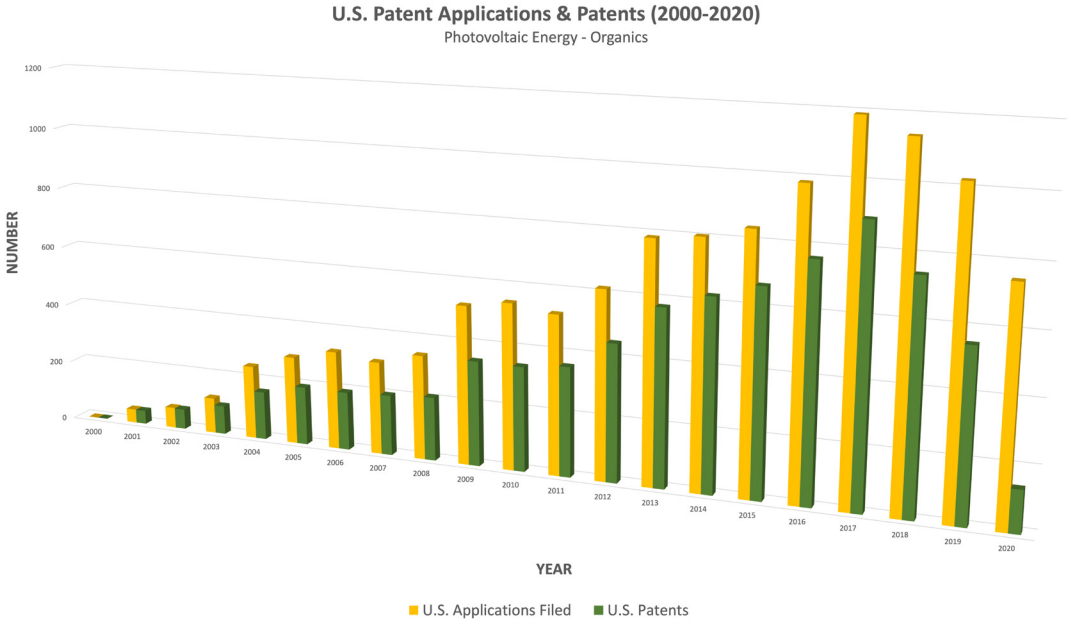
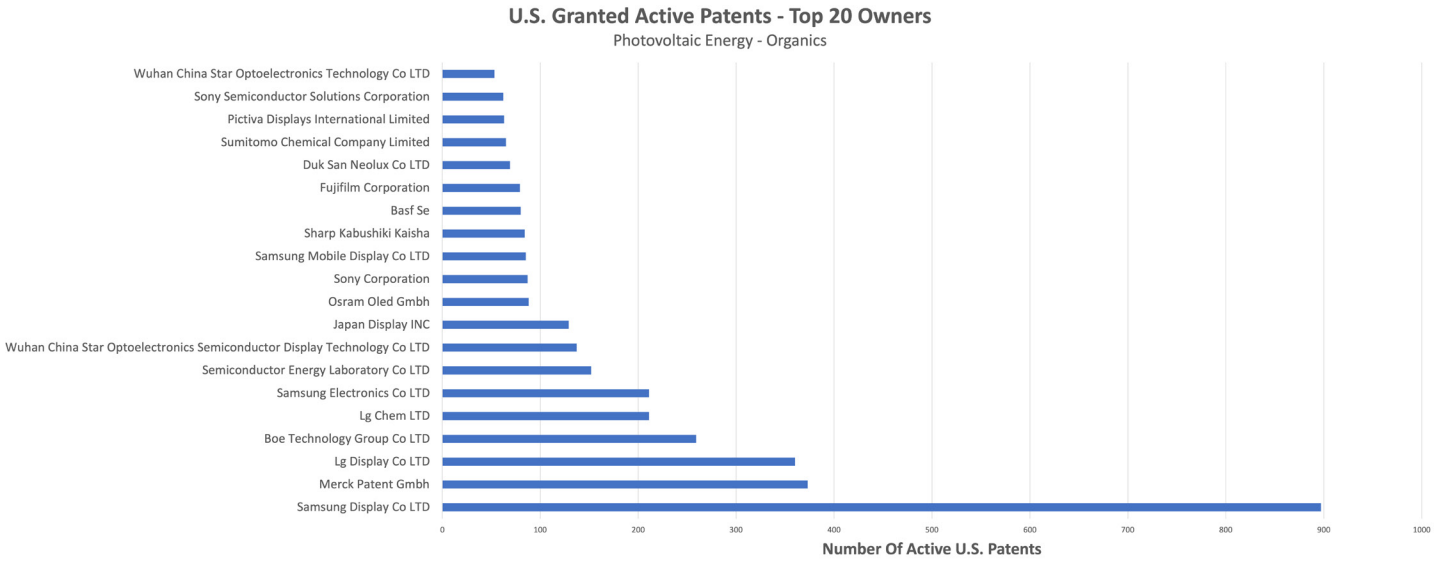


Image Source: U.S. Department of Energy

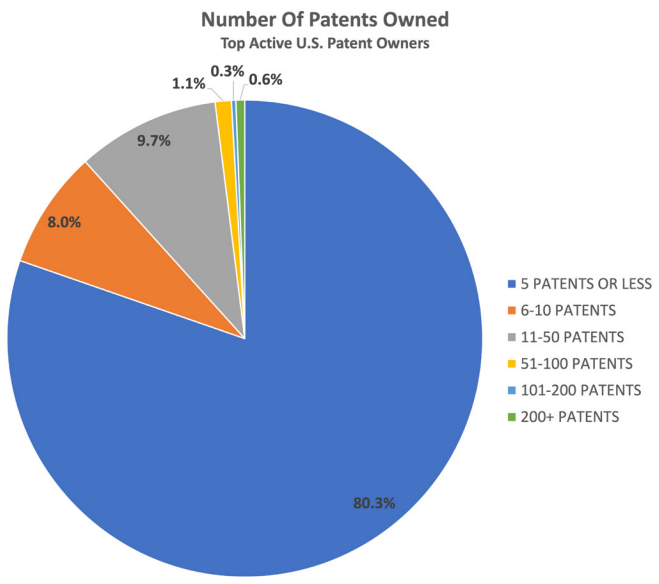
The benefits promised by OPV solar cells include:

1. Low-cost manufacturing: Soluble organic molecules enable roll-to-roll processing techniques and allow for low-cost manufacturing.
2. Abundant materials: The wide abundance of building-block materials may reduce supply and price constraints.
3. Flexible substrates: The ability to be applied to flexible substrates permits a wide variety of uses[3].





U.S. patent application activity for Organic solar cell technology generally experienced tremendous growth from 2000-2017. From 2015-2019 there has been an average annual growth of 6% in the number of applications filed for Organic solar cell inventions, albeit with a decline in 2018-2019. The number of U.S. patents granted has experienced a 17% rate of decline from 2015-2020. Approximately 42% of unexpired Organic solar cell patents are owned by the top 1% of owners for such patents. However, as shown in the accompanying pie chart, 88% of the top owners own 10 or fewer of such U.S. patents.



U.S. PATENT APPLICATIONS[2] - Photovoltaic Energy	
Total U.S. Applications Filed 2015-2019	5179
Average Annual Growth (2015-2019)	+6%
Number Currently Pending In The USPTO	1374
USPTO Technology Center (TC)	2800
USPTO Technology Group (TG)	2810
Avg. TC Time To First Office Action (Months)	15.7
Avg. TC Application Pendency (Months)	21.8
Avg. TC Application Grant Rate (3 Year)	82%
Avg. TG Application Grant Rate (3 Year)	80%
Avg. TC Pendency Of An Appeal (Months)	12.2
Reversal Rate For TC On Appeal	43%
U.S. PATENTS[2] - Photovoltaic Energy	
Unexpired Patents	6690
Number Granted (2015-2020)	3627
Avg. Annual Growth Rate (2015-2020)	-17%
Percentage Held By Top 1% Of Owners	42%

U.S. PATENT LANDSCAPE
Photovoltaic Energy - Perovskites

Perovskites are a family of materials with a specific crystal structure, named after the mineral with that structure. When used to create solar cells, they have shown potential for high performance and low production costs. Perovskite devices have exceeded all thin-film technologies, except III-V technologies, in power conversion efficiency, showing rapid improvements over the past five years[3].

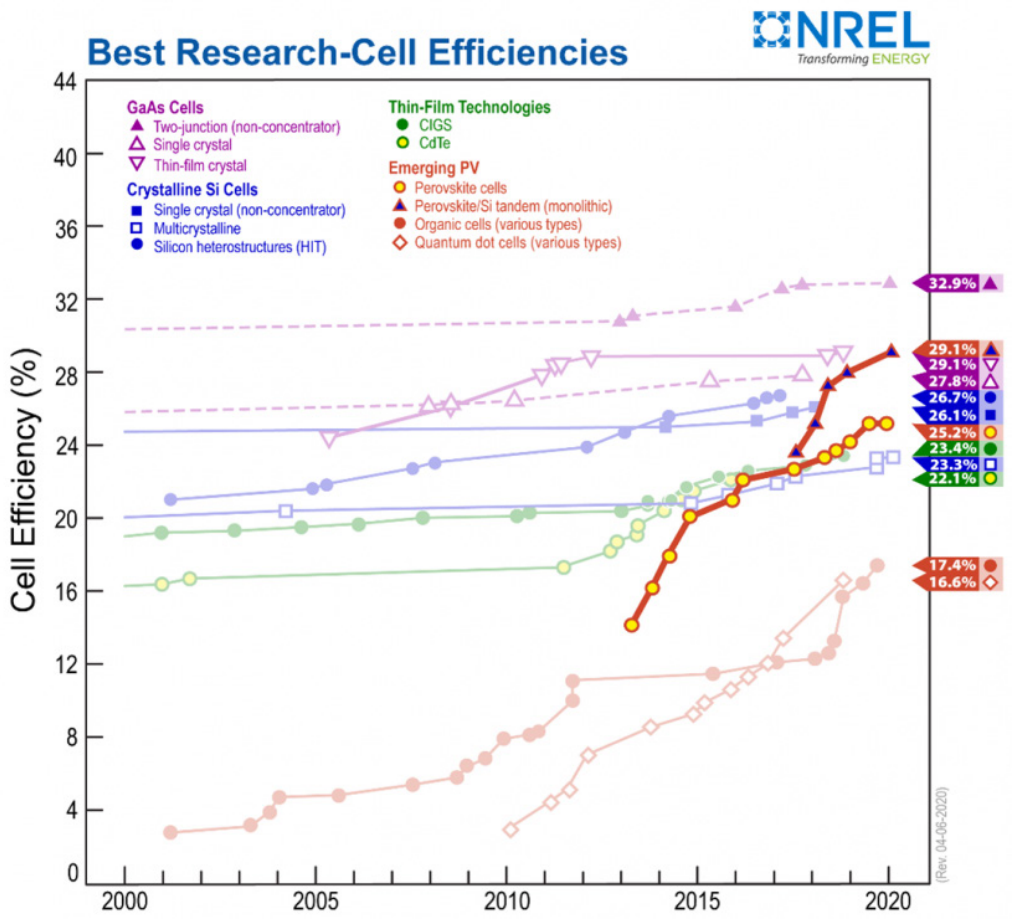


Image Source: U.S. Department of Energy

Perovskites can be tuned to respond to different colors in the solar spectrum by changing the material composition, and a variety of formulations have demonstrated high performance. This bandgap flexibility opens up another useful application for perovskite solar cells in high-performance tandem device architectures, with potential power conversion efficiencies over 30%. In these structures, perovskites are combined with another, differently tuned absorber material to deliver more power. Perovskite solar cells of certain compositions can convert ultraviolet and visible light into electricity very efficiently, meaning they might be excellent hybrid-tandem partners for absorber materials such as crystalline silicon that efficiently convert infrared light. It is also possible to combine two perovskite solar cells of different composition together to produce a perovskite-only tandem. Doing so could lead to even higher efficiency and more cost-effective tandem photovoltaic (PV) applications. Perovskite-only tandems could be particularly competitive in the mobile, disaster response, and defense operational energy areas, as they can be produced on flexible substrates with high power-to-weight ratios[3].

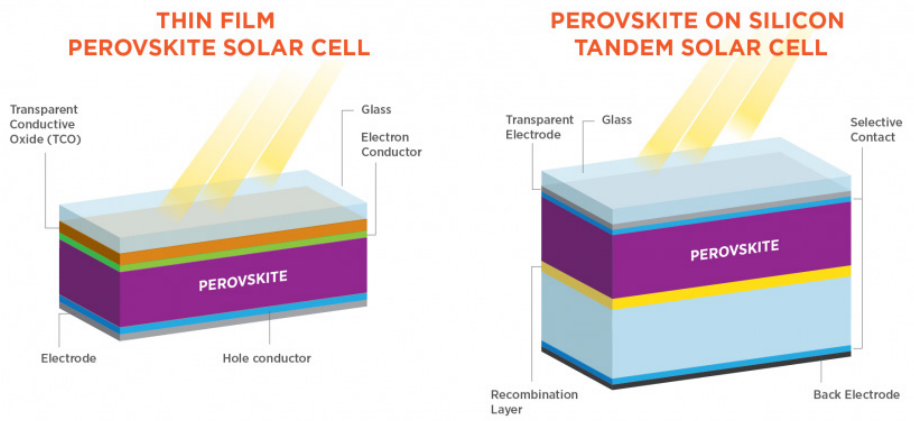
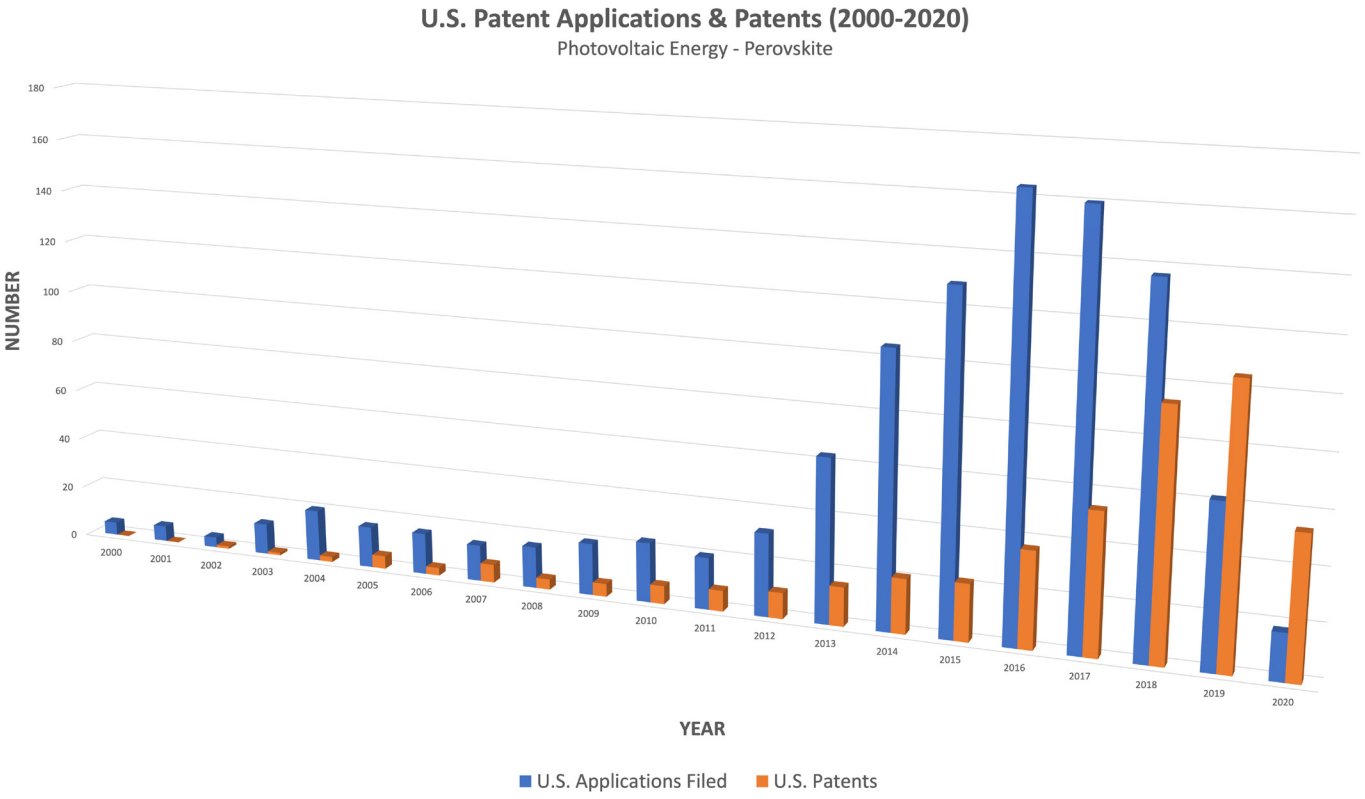


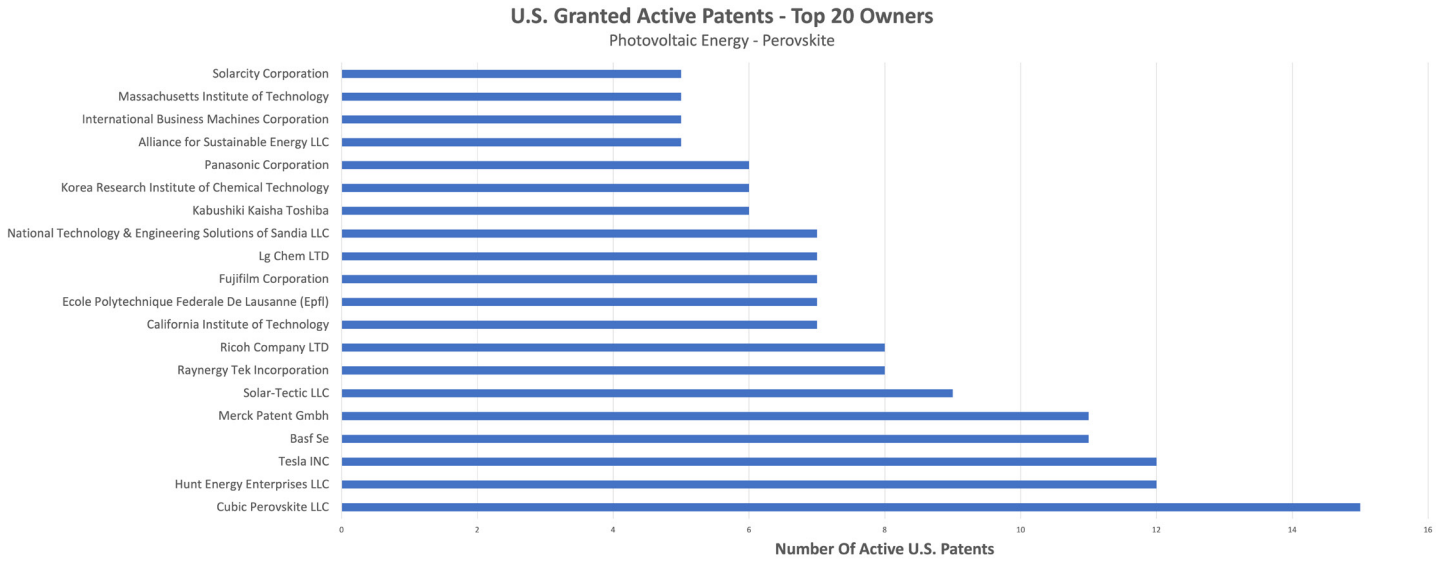
Image Source: U.S. Department of Energy

The Solar Energy Technologies Office (SETO) of the U.S. Department of Energy has identified four primary challenges that must be simultaneously addressed for perovskite technologies to be commercially successful.

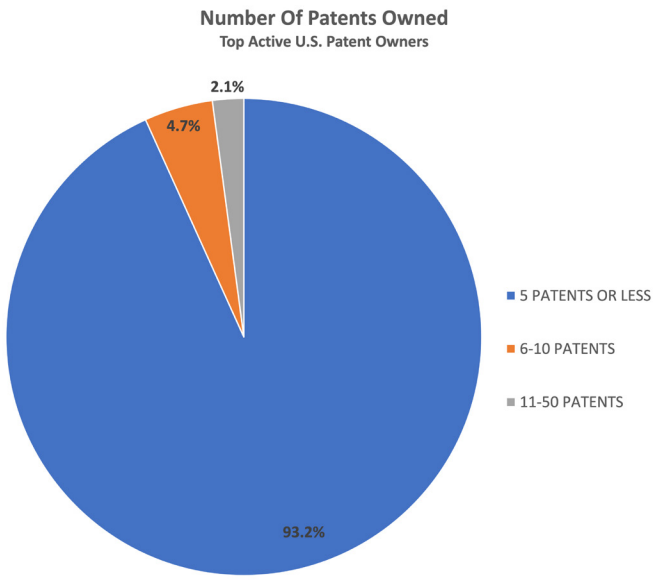
1. Power Conversion Efficiency
2. Stability & Degradation
3. Manufacturability
4. Technology Viability & Bankability

The SETO is supporting projects working to address these challenges through funding research and development to improve the understanding of perovskite stability to enable domestic production of high-efficiency perovskite devices. It is to be expected that such research and development may lead to inventions which could reverse a downward trend in recent years for perovskite patent application filings[3].





U.S. patent application activity for perovskite solar cell technology generally experienced tremendous growth from 2012-2016. From 2015-2019 however there has been an average annual decline of 10% in the number of applications claiming perovskite inventions filed. The number of U.S. patents granted has experienced a growth rate of 30% from 2015-2020. Approximately 9% of unexpired perovskite solar cell patents are owned by the top 1% of owners for such patents. However, as shown in the accompanying pie chart, more than 97% of the top owners own 10 or fewer of such U.S. patents.



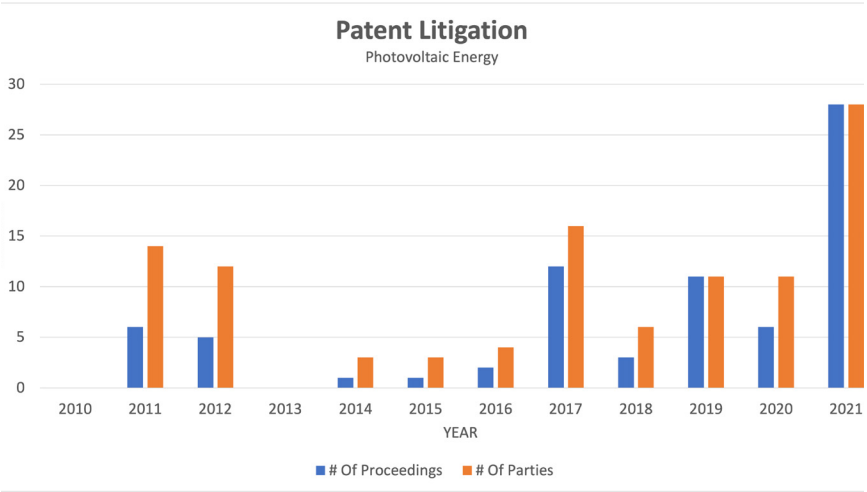
U.S. PATENT APPLICATIONS[2] - Photovoltaic Energy	
Total U.S. Applications Filed 2015-2019	652
Average Annual Growth (2015-2019)	-4%
Number Currently Pending In The USPTO	239
USPTO Technology Center (TC)	1700
USPTO Technology Group (TG)	1720
Avg. TC Time To First Office Action (Months)	16.2
Avg. TC Application Pendency (Months)	26.6
Avg. TC Grant Rate (3 Year From FOA)	61%
Avg. TG Grant Rate (3 Year From FOA)	57%
Avg. TC Pendency Of An Appeal (Months)	12.7
Reversal Rate For TC On Appeal	42%
U.S. PATENTS[2] - Photovoltaic Energy	
Unexpired Patents	413
Number Granted (2015-2020)	312
Avg. Annual Growth Rate (2015-2020)	+30%
Percentage Held By Top 1% Of Owners	9%

Photovoltaic Energy - U.S. PATENT LITIGATION

Litigation For Unexpired U.S. Patents Classified As Photovoltaic Energy

Patent Owner/Licensee	Infringer(s)/Challenger(s)	Patents
Sensor Technology	Mouser Electronics Lite-On	9,330,906 10,460,952 8,552,562 10,147,848 10,854,785 9,966,496 9,042,420 10,411,156 9,923,117
Alpine	Quanzhou Keyang Electronics & Technologies	10,231,039
Tigo	Altenergy Power Systems Sunspec Alliance	10,256,770 8,933,321
Advanced Silicon Group Technologies	Boviet Solar Canadian Solar Hanwah Q Cells Advanced Materials	8,450,599 8,852,981 9,601,640 9,768,331 10,269,995 10,692,971
Solaria Corporation	Canadian Solar	10,522,707 10,651,333 10,763,388
Ecofasten	Unirac Bamboo Industries Wencon Development Ecolibrium Solar Ironridge	10,763,777 10,676,929 8,153,700 9,134,044 9,447,988 9,774,292 9,793,853 6,526,701 9,010,038 9,422,723
Dupont	Sun Edison NVT Heraeus Precious Metals Solarworld	8,497,420 7,767,254 8,158,504
FCX Solar	FTC Solar	10,903,782
Nextracker	Nevados Engineering Sunlink Solar Flexrack Northern States Metals Company	11,101,768 11,043,607 9,806,669 9,970,686
Andalay Solar	Zep Solar Global Resource Options Gro Solar High Sun Technology	7,406,800
Unirac	Ironridge JAC-Rack Solar Solutions International Wencon Development ESDEC Ecofasten Solar Pegasus Solar	7,260,918 7,434,362 7,748,175 7,766,292 8,128,044 9,057,542
Zep Solar	Westinghouse Solar Akeena Solar Andalay Solar Lightway Green New Energy Brightway Global Morrison Supply Co. Sky Solar Solutions Alternative Power & Electric	7,592,537
Blue Sunny Skies	PV Thermal Solarrac2 MJM Fabrications Dave Lewenz	6,968,654
Bigbelly Solar	Ecube Labs Co.	7,124,680 7,481,159
Solar Paste	Changzhou Fusion New Material Co. Risen Solar Co. Risen Energy America	7,767,254 8,497,420 8,889,979 8,889,980 8,895,843
Harvard College	Hamamatsu Photonics Ocean Optics	7,884,446 8,080,467 8,680,591
Array Technologies	Exosun Arcelormittal	8,459,249
Strategic Solar Energy	Affordable Solar Installation	8,825,500
SMA Solar Technology	Solar Edge Technology	8,779,630
Hanwah Q Cells	Jinkosolar Longi Solar REC Solar	9,893,215 8,933,525
Nanolumens	Infiled USA Detailed Solutions Shenzhen Infiled Electronics Co. Gable Signs & Graphics Pixelflex	8,963,895 9,159,707 9,640,516
Luminaid Lab	MPowerd	9,347,629
Rondevoo Technologies	Aernos Sensirion	9,453,814 9,927,391
Permacity	Orion Solar Racking	9,742,347 9,985,574
Solar Junction	IQE	9,768,339

Litigation between parties in the U.S. involving patents occurs through the U.S. federal district courts, the U.S. International Trade Commission (USITC), the United States Patent & Trademark Office (USPTO), and (infrequently) private arbitration proceedings. While litigation activity involving unexpired U.S. patents classified as being for photovoltaic energy has been relatively low, it has experienced an average annual growth rate of 203% since 2016. Of the unexpired U.S. patents classified as photovoltaic energy 72 have been litigated since 2010. Since 2016 *inter partes* reexaminations at the USPTO (which are third party challenges to the validity of an issued patent) have been the most common proceeding involving unexpired photovoltaic energy patents. With the predicted dramatic expansion of solar power energy in the U.S., an accompanying increase in litigation involving the many unexpired photovoltaic energy patents may be expected.



Appendix

About This Report

This tIPs special report has been published as a public service by attorney David M. Kleiman. It aims to provide valuable information and perspective on intellectual property rights issues impacting the solar power industry. It is a free resource.

DISCLAIMER: The information presented herein is for general information purposes only, and it comes with no warranty of any kind with regards to accuracy. This publication is not intended to be, and should not be relied upon, as legal, business, or tax advice. While the publisher is an attorney, the report is not an offer to provide legal services and is not intended as attorney advertising.

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References

1. *Solar Futures Study*, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, September 2021.

2. Data sources whch may have been consulted in preparing this publication included the United States Patent & Trademark Office, The Administrative Office of The U.S. Courts, The Lens, RPX, Patent Bots, WIPO, and Google Patents.

3. This text was obtained from the website of the United States Department of Energy.

4. The United States patent laws and regulations referenced herein may generally be found at 35 U.S.C. § 1 et seq. and 37 CFR § 1.1 et seq.

5. *U.S. Puts $562 Billion Price Tag On Boosting Solar Power by 2050*, Timothy Puko and Jennifer Hiller, Wall Street Journal, September 9, 2021.

A patent is a legal document that sets forth in writing a set of national legal exclusivity rights in an invention. A patent is acquired by filing a written application with the appropriate national government agency (e.g., the United States Patent & Trademark Office). A patent application must set forth a detailed description, drawings as needed, and a precise legal claim for the invention.

An examiner employed at the national government agency will examine the filed application to determine if it complies with the legal requirements for obtaining a patent in that jurisdiction. In the United States Patent & Trademark Office the examiners are employed in numbered "Technology Centers" which each deal with a particular area of technology (e.g., Technology Center 1700 covers Chemical and Materials Engineering). The examiners working in each Technology Center are then further divided into "Technology Groups", with each Technology Group having an even more specific technological focus (e.g., Technology Group 1720 is for Fuel Cells, Battery, Flammable Gas, Electrophotography, Photolithography). Patent applications are matched to examiners based upon the subject matter of the application matching that of the Technology Group.

In general, the primary legal requirements that an examiner checks for are that the claimed invention is (1) eligible subject matter, (2) novel, and (3) non-obvious. If a claimed invention is a useful process, machine, article of manufacture, or composition of matter, then in general it is eligible subject matter. Note that this covers an enormous amount of subject matter because so many things can be described as fitting into one of these broad categories. A claimed invention will be novel if the same invention wasn't already in the prior art (i.e., it wasn't already known at the time the application was filed). A claimed invention will be non-obvious if the differences between the invention and what is in the prior art would not have been obvious to those having skill in the art.

It is quite common during the patent application examination process to receive rejections of an application for allegedly failing to meet one or more of the legal criteria. However, if through amendment and/or arguments the government examiner is ultimately persuaded that all of the legal criteria for a valid patent are satisfied, then the application will be allowed to issue as a patent.

Once issued, the set of national legal exclusivity rights the owner of an issued patent enjoys typically includes the exclusive right, within national boundaries, to make, use, offer to sell, sell, and import the invention claimed in the patent. These exclusive rights exist for a fixed period. For U.S. utility and plant patents the time is typically 20 years from the date the application was filed. For U.S. design patents the term is 15 years from the date of issue.

The exclusive rights of a patent may be sold or licensed by the owner, in whole or in part. They may also be enforced by the patent owner through the courts against those who infringe upon the rights without permission of the patent owner. An infringer of a patent could be held liable in a patent infringement lawsuit for monetary damages (no less than a reasonable royalty in the U.S.), punitive damages if the infringement was willful, and the attorney fees and court costs of the patent owner. In addition, the infringer may be subject to court injunction barring the infringer from any further use or sale of the invention.

It is important to note in today's global economy that there is no such thing as a "worldwide" patent. Each nation issues its own patents and has its own system for the enforcement of patent rights. There are patent treaties between countries, including the Patent Cooperation Treaty ("PCT") which establishes a system for the filing of a single "international patent application" that can be used in multiple jurisdictions. However, any person who wants patent rights in a country for an invention must obtain patent protection from the national government of that country, and if necessary enforce those patent rights in that country.


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