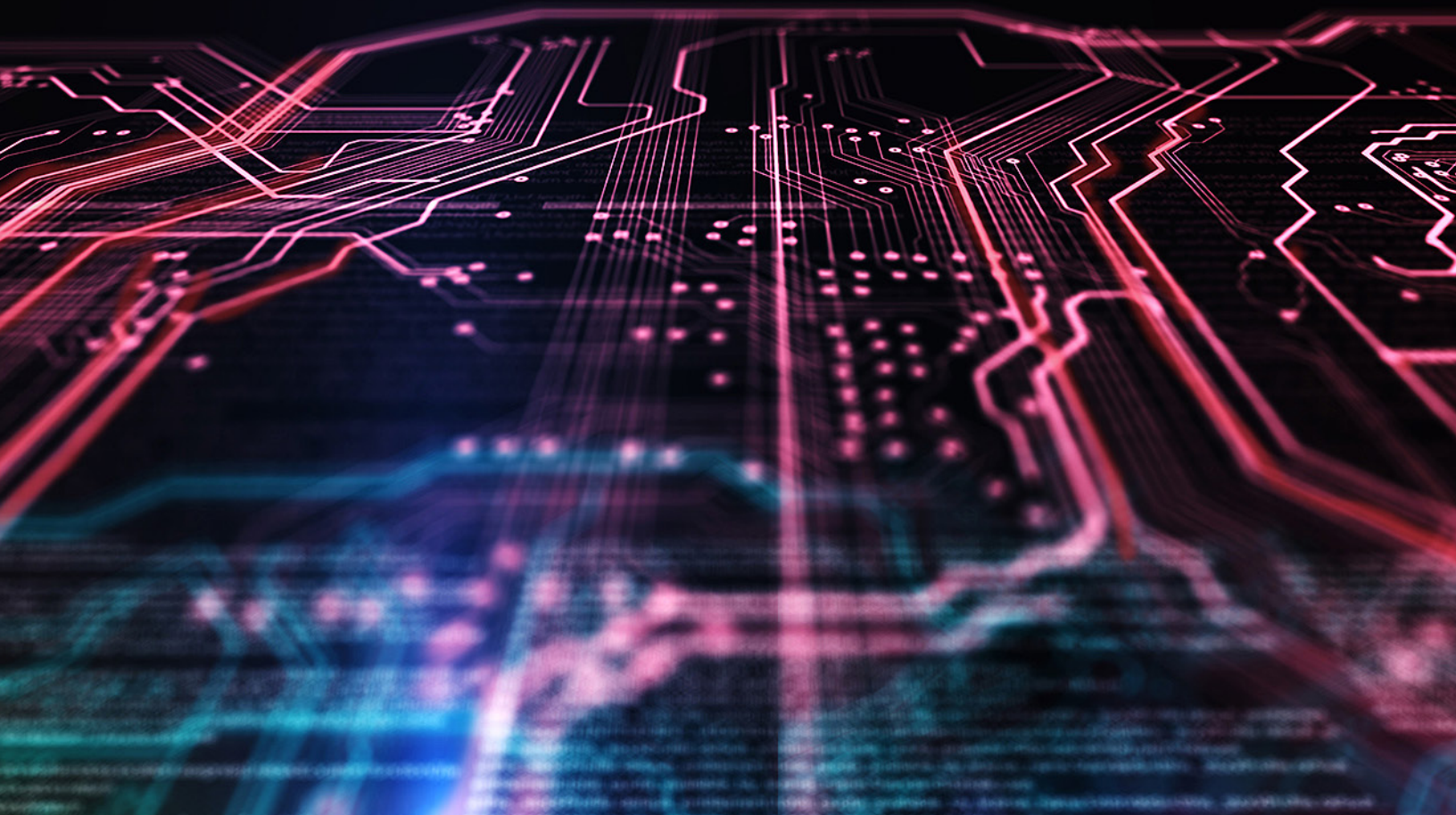


2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS



GREENTECH

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Expectations for greentech are rising as governments and consumers put increased emphasis on environmental sustainability, in turn exerting increasing pressure on businesses across the economy.

SECTOR OVERVIEW

What Is Greentech?

Greentech is an umbrella term that covers a broad array of technologies associated with improving environmental sustainability and energy and other resource efficiency across the economy. Companies that develop green technologies are often said to be part of a greentech subsector.

It is related to—and sometimes used interchangeably with—the term cleantech. The term climate tech is also used to describe the subset of those technologies that are intended to reduce greenhouse gas (GHG) emissions or mitigate the impacts of climate change.

Associated Sectors

- Energy
- Transportation/Mobility
- Agriculture and Food
- Manufacturing
- Construction

Greentech is closely associated with the energy sector, specifically the development and application of new solutions to generate, store, distribute, and expend energy that have a smaller environmental footprint than hydrocarbons. Within the energy sector, greentech is also sometimes referred to as clean energy, renewable energy, smart energy, or energy tech.

Various emerging greentech businesses target industries outside of the energy sector with a significant GHG footprint or other substantial environmental impacts. The transportation,

manufacturing, agriculture, and construction sectors are growing areas of interest, for example.

Why Is It Important?

Expectations for greentech are rising as governments, investors, businesses, and consumers put increasing emphasis on environmental sustainability. Companies in various industries are looking for ways to decrease their carbon footprint, water use, and environmental impacts, and existing and emerging green technologies are helping organizations meet more aggressive environmental and sustainability goals. In addition, leading private and institutional investors seeking to mitigate climate risks and bolster long-term value are pushing for companies to improve their environmental records and sustainability efforts.

Bumpy History, but Positive Outlook

The recent history of investments in sustainable technologies includes the so-called cleantech boom of the late 2000s and early 2010s that was followed by a downturn that marked much of the last decade.

Recently, the outlook for companies focused on greentech has been turning positive, as a result of improvements in sustainable technologies, coupled with decreases in pricing for greentech infrastructure, a renewed focus on human-caused climate change, and increasing government, investor, and consumer attention on sustainability in recent years.


GREENTECH

SECTOR OVERVIEW (CONT'D)

Analysts are reporting more early-stage investment in greentech companies and technologies, and, over the past four years, investors representing over \$60 trillion in assets under management have committed to driving action on climate change across their portfolios. Further, the movement among large commercial and industrial consumers of power, including technology companies such as Google, Meta and Microsoft, to achieve carbon-free energy consumption targets continues to gain momentum and drive increasing demand for renewable energy.

Innovation in Greentech Requires New Legal Strategies

Breakthrough developments in green technologies are helping to propel the economy, driving growth in key sectors such as transportation, manufacturing, agriculture, and construction, and have the potential to reduce emissions and other environmental impacts. Many of these innovative technologies are also generating unique legal and regulatory issues that require foresight and preparation. For greentech, such issues can involve a wide range of issues, including those related to privacy and data protection, cybersecurity, use of artificial intelligence and machine learning, intellectual property, blockchain, and trade, among others.



**THE U.S. GOVERNMENT AIMS TO
REDUCE GHG EMISSIONS TO PRE-2005
LEVELS BY 2030 AND TO ACHIEVE
NET-ZERO EMISSIONS BY 2050.**

GREENTECH

ENABLING SCIENCE AND TECHNOLOGY

Industries Poised to Benefit From Technology Advances

There are many exciting areas of science and technology research that fall within the greentech category; we have highlighted several below that are considered by industry analysts to be essential to the next generation of breakthroughs. Many of these developments will directly benefit the energy and power distribution sectors, as they will facilitate the generation, storage, and distribution of clean energy. However, other sectors are also poised for potentially significant boosts from such breakthroughs.

The recent increase in sustainable technology funding, coupled with a stronger alignment of government policy priorities, points to more robust years ahead for new greentech patent applications.

Energy

Several promising technological developments pertain to the increased deployment and use of clean energy. A primary focus is battery technology, including advances in lithium-ion battery technology—however, green hydrogen, smart energy grids, and other technologies also will play a role. Advanced storage solutions and smart energy technologies could help electricity producers and distribution utilities manage the intermittent nature of the most promising renewable production technologies, such as solar and wind, while cheaper, more powerful, and longer-lived batteries would support further growth within the electric vehicle market.

In addition, technological developments that permit construction of small modular reactors (SMRs), including microreactors, could offer opportunities for reliable carbon-free energy in areas that have limited infrastructure or lack sufficient access to other renewable energy sources, with a reduced environmental footprint and without the same safety risks associated with traditional nuclear power reactors.

Green Hydrogen

Green hydrogen is another promising area. Green hydrogen is created from water using electrolysis produced from renewable power and leaves no by-products other than oxygen. Although hydrogen is a promising fuel source and energy storage medium, the two most cost-effective ways to produce it currently rely on natural gas, creating a CO₂ footprint (gray hydrogen) or an extra carbon capture step (blue hydrogen). If scalable production of green hydrogen can be achieved, it is likely to become a pillar of decarbonization, according to reporting by Wood Mackenzie, with a wide range of potential applications.

Carbon Capture and Storage

Carbon capture and storage technologies remove CO₂ from both industry and the atmosphere and put it in long-term storage. Carbon capture can take place in three stages where hydrocarbons are burned during industrial processes: pre-combustion, post-combustion, and during combustion. Once captured, the CO₂ is dissolved into a solvent that must be stored in a sealed location. Advances in technologies related to carbon capture and storage could create an easier path to long-term decarbonization by enabling the continued use of hydrocarbons in the short term, while still meeting reduced emissions goals and allowing time for the transition to alternative energy sources to take place.

In addition, research is being conducted into direct air carbon capture and storage (DACCS). DACCS technologies capture previously released CO₂ from the atmosphere and either lock it up in the ground or use it, for example, in industrial products such as concrete or by combining it with hydrogen to

GREENTECH

ENABLING SCIENCE AND TECHNOLOGY (CONT'D)

produce synthetic fuels. While these technologies are still in early stages of development, analysis from the [International Energy Agency \(IEA\)](#) and [other research](#) indicates that they could play an important role in mitigating the impact of climate change. Interest in carbon capture and storage is driven by the imperative to lower GHG emissions more rapidly than relying on the more gradual transition to renewable energy sources.

Photovoltaic and Wind Generation

While solar and wind technologies have existed for decades, research and technological developments are continuing to lower the cost of such technologies, increase output, and improve efficiency and durability. These technologies will continue to accelerate the deployment of solar and wind generation facilities, while new technologies, such

as perovskite solar cells, could further lower costs of renewable generation.

Convergence With Other Emerging Technologies

Other areas of emerging science and technological developments are converging to [accelerate](#) new green technologies that will help make major industries more sustainable. For example, artificial intelligence, machine learning, and blockchain can enable rapid and ongoing optimization, decentralization, and enhanced security. Cloud computing and wireless technologies mean that greentech solutions can be deployed and distributed further, faster, and in more places.



BREAKTHROUGH DEVELOPMENTS IN GREEN TECHNOLOGIES ARE HELPING TO PROPEL THE ECONOMY AND DRIVE GROWTH IN KEY SECTORS SUCH AS TRANSPORTATION, AGRICULTURE, AND CONSTRUCTION AND HAVE THE POTENTIAL TO REDUCE EMISSIONS AND OTHER ENVIRONMENTAL IMPACTS.

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SECTOR AND INDUSTRY SIGNALS

Corporate Leaders Pledge Zero Emissions and Launch Major Funds

In 2019, Amazon pledged to achieve net-zero carbon emissions by 2040 and launched a \$2 billion Climate Pledge Fund to support the development of green technologies. Microsoft and Unilever also have made aggressive emission pledges and launched their own climate-focused funds (\$1 billion and €1 billion, respectively), while over 1,800 companies have committed to net-zero emissions by 2050 via the Science Based Targets initiative. These are strong signals of demand—and financial support—for emerging greentech companies.

Leading Investment Managers Focus on Climate Opportunities and Risks

Leaders in the asset management sector—notably BlackRock and State Street Global Advisors—have recently put corporate boards on notice that environmental sustainability and other nonfinancial matters are increasingly important investor considerations. Funds, in turn, offer a growing number of options for investors to screen for environmental, social, and governance considerations.

Increasing Adoption of Electric Vehicles and Charging Networks

An increasing number of automakers are announcing plans to increase their electric vehicle offerings and some, such as General Motors, Volvo, and Jaguar, are planning to shift to selling only electric vehicles within the next 10 to 15 years.

In January 2021, Royal Dutch Shell Plc, which has been investing heavily in renewable energy assets and the mobility sector since setting out a net-zero emissions by 2050 goal in April 2020, announced the acquisition of Ubitricity, a European electric vehicle charging network. The combination of Ubitricity's on-street charging sites and technologies and Shell's retail locations could accelerate electric vehicle adoption in Europe.

Aircraft Manufacturers Planning Zero-Emission Commercial Planes for 2030s

According to its 2021 Sustainability Report, Boeing has committed that its commercial airplanes will be capable of and certified to fly on sustainable aviation fuels by 2030. Boeing also is researching and investing in electrification technologies as well as supporting research to develop technology for green hydrogen fueled aircraft.

Wright Electric, a World Economic Forum Technology Pioneer, is developing a zero-emissions passenger plane capable of operating at the same cost as a fuel-based model, and aims to reach market by 2030. Meanwhile, European conglomerate Airbus is considering three different concepts for its own zero-emissions commercial aircraft, and it hopes to have one entering service by 2035.

Penn State Researchers Generating Hydrogen Fuel From Seawater

A Penn State research team integrated water-purification technologies with an electrolyzer, converting seawater to hydrogen, with a proof-of-concept design. Funded by the U.S. National Science Foundation (NSF), this development has the potential to eliminate a major barrier to using the most abundant source of water (i.e., seawater) for green hydrogen production.

Other areas of emerging science and technological developments are converging to accelerate new green technologies that will help make major industries more sustainable.

GREENTECH

IMPACT

Economic

Advances in renewable energy generation and storage will accelerate the decarbonization of the energy economy, and also lead to major shifts up and down the current energy supply chain, according to industry analyst [Wood Mackenzie](#) and others. This is because some electric generation will be more distributed and closer to end markets, a shift that will create new opportunities for alternative energy producers and distributors. In addition, large-scale industrial energy users, such as manufacturers, will be able to take advantage of greater diversity and competition in the energy market, while also reducing their own carbon footprints.

Social

Social pressure is increasing on energy producers and manufacturers for more sustainable goods and services, according to [analysis](#) by PwC. While various greentech developments have the potential to improve sustainability and reduce environmental impacts within the key sectors identified above, the gains from such developments will need to be balanced with associated social, economic, and environmental impacts.

Increasing access to affordable and reliable renewable technologies that have the potential to make electricity available at a lower cost to more people, even in remote locations where access to traditional utilities is difficult, is a focus. However, certain adverse consequences associated with deploying such technologies will need to be considered and, ideally, shared more equally among communities.

The widespread adoption of lower-impact, less-polluting technologies also presents opportunities to reduce certain social, economic, and environmental issues that have disproportionately burdened certain communities, allowing such communities a chance to recover. Over the longer term, greentech technologies could help reduce the risk of disruptions caused by large-scale population displacement due to rising sea levels, extended drought, or severe weather if the implementation of such technologies can sufficiently mitigate the negative consequences of climate change.

Environmental

An essential premise of greentech is that science and engineering can reduce—and possibly reverse—the negative impacts that businesses and people have on the natural environment. One focus of green technology is to reduce the release of greenhouse gases, which are identified as the main contributor to climate change. Other significant environmental changes that green technologies could enable include reduced industrial consumption of fresh water, reduced plastic waste, and reduced air pollution, among others.

Although certain greentech development paths could have significant benefits, other environmental challenges may emerge as a consequence. For example, certain advanced battery designs have created an increased demand for select metals and chemicals, potentially increasing environmental damage caused by extraction and production processes. Further, the disposal of advanced technology products could create new sources of pollution. Consequences such as these could be ripe areas for further innovation in the future.

Policy

Globally, more than 100 countries have committed to net-zero emissions by 2050, and analysts expect the policies stemming from these pledges to include subsidies for green technologies and infrastructure spending, carbon pricing, and new bans and phase-out periods for high-impact products and processes.

In the United States, the Biden administration has announced a goal of reducing GHG emissions to pre-2005 levels [by 2030](#) and achieving [net-zero emissions by 2050](#). In addition, 24 states and Washington D.C., have established greenhouse gas reduction targets, including many [carbon neutrality](#) and [net zero](#) goals. These goals are informing new policy directives and rulemaking across the federal government, and driving new spending and investment-attraction initiatives on sustainable technologies and the infrastructure to deploy them.

GREENTECH

LEGAL IMPLICATIONS

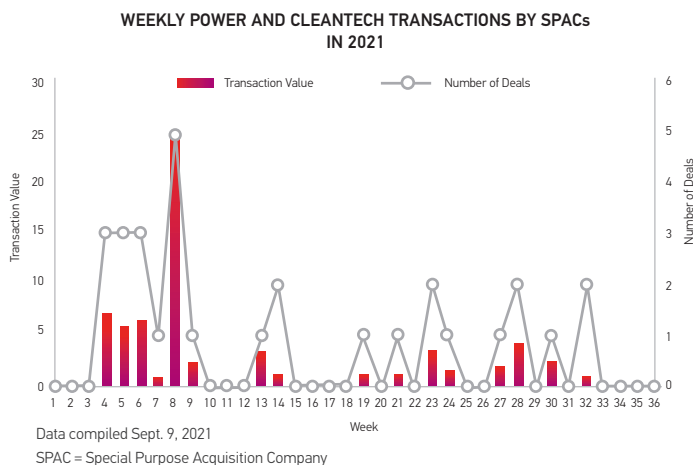
OUTLOOK

Transactions and Financing | Early-Stage Funding Rising Fast, Use of SPACs to Go Public

Funding for greentech businesses has been increasing recently after years of muted interest. In the climate tech category, for example, total funding, average funding levels, and startup creation rates are all on the rise, according to [analysis](#) by PwC. Larger deals (i.e., over \$100 million) are a significant part of the funding growth, which may signify a new degree of maturation in the greentech ecosystem.

Such a level of activity is likely to continue as long as the overall greentech environment remains positive, though as investors witnessed previously, this sector can be more sensitive to changing government policies (e.g., investment, trade, and regulatory) than others.

As greentech companies mature and consider going public, many are following the trend of listing through a merger with a special purpose acquisition company (SPAC). In fact, U.S. public listings by SPACs with a broad sustainability focus were already [increasing early in 2021](#), with 49 such listings in the first four months of 2021 alone. A report by S&P Global indicates that there had been nearly three dozen [cleantech SPAC deals](#) through the end of August 2021, largely in the energy sector.

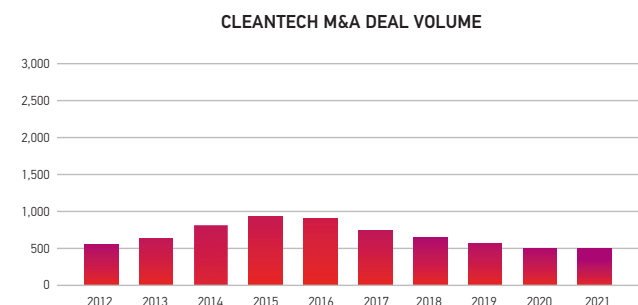
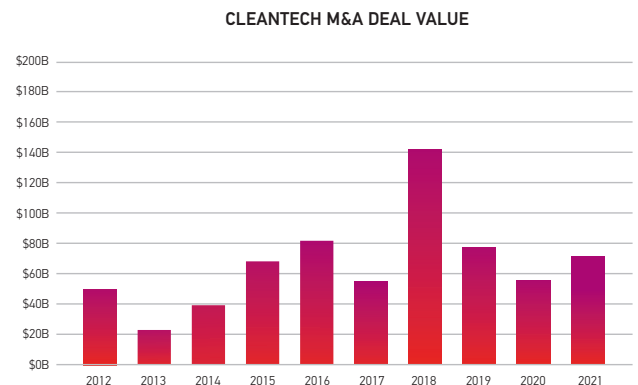


Source: S&P Global Market Intelligence; Raymond James

In addition, an ever-widening variety of power contracting structures are growing out of consumers' interest in achieving 100% renewable energy for their power needs. Over the last decade, virtual and physical power purchase agreement structures have been developed to enable consumers to match annual electricity demand with annual carbon-free energy production. Increasingly, consumers are using sophisticated models to understand the carbon intensity of grid-sourced energy at all hours of the day and are exploring ways to match their hourly electricity demand with carbon-free energy.

M&A Muted in 2020, Activity Renewed in 2021

Until recently, the pace of mergers and acquisitions activity has been relatively flat, with deal volume remaining well below the levels achieved in the mid-2010s. However, there are signs that the market may be picking up, with the number of deals in 2021 eclipsing those completed in 2020. Total deal value was well above the previous year's level, according to data from Pitchbook.



Source: PitchBook, September 28, 2021

GREENTECH

LEGAL IMPLICATIONS (CONT'D)

Litigation | New Product Performance and Government Incentives

The litigation outlook for greentech companies reflects the widely varying technologies and their uses, but there are a few areas to watch.

As more products that incorporate green technology elements become available in the market, product liability claims are likely to rise as typically happens with any new class of products put to test in the “real world.”

In addition, as the number of government incentives intended to encourage the development of sustainable technologies grows—such as tax breaks, grants, and loan programs—disputes may arise related to which organizations qualify for them, or to which parties the benefits should flow within greentech partnerships.

Cybersecurity | Threats on the Rise

Greentech includes the use of many digital tools, platforms, and processes—in energy production and distribution, electric vehicles, other mobility solutions, and more. Increased digitization translates to a higher level of cybersecurity risk, requiring increased defenses and risk mitigation strategies. The number of targeted attacks against the energy sector alone rose from 87 in early 2015 to 155 by the end of 2019, according to a 2021 World Economic Forum (WEF) [report](#). Grid infrastructure, nuclear plants, gas pipelines, and safety systems for oil production operations have all been targets of cyberattacks in the past five years.

Regulatory and Compliance | New Priorities in the United States

The Biden administration has signaled that it intends to take a more active approach in its efforts to combat climate change and address other environmental priorities through public commitments and executive orders. This shift is expected to mean the establishment of more stringent regulations and increased enforcement activity.

Globally, other governments continue to take actions intended to combat climate change, which include carbon pricing, new regulatory mandates, and other measures.

Trade | Lingering Barriers

Global trade barriers increased—though not consistently—in the last decade. While there are some signals that outright trade wars may be on the wane, a certain degree of protectionism and trade uncertainty is expected to persist, and flare-ups may create headwinds for greentech companies that sell (or source) internationally. Some green technology companies, such as those that develop or manufacture alternative energy generating equipment (e.g., solar panels, wind turbines), may be more sensitive to these changes, particularly given the emergence of China as a leading manufacturer of necessary components.

Most recently, targeted trade bans and disrupted international supply chains may be putting large solar projects [at risk](#).

LITIGATION AND REGULATORY DEVELOPMENTS

States Seek Curbs on Federal Government's GHG Regulation Authority

In April 2021, nineteen states filed an appeal with the U.S. Supreme Court seeking to overturn a decision of the U.S. Court of Appeals for the District of Columbia Circuit that would increase the Environmental Protection Agency's authority to regulate GHG emissions. The circuit court decision in question vacated a Trump administration decision to roll back Obama-era standards known as the Clean Power Plan and replace them with the less-stringent Affordable Clean Energy Rule. The case is scheduled for argument on February 22, 2022. Significantly, a group of innovative technology companies, including Amazon, Apple, Google, Meta, and Microsoft filed an amici brief in support of the Environmental Protection Agency's (EPA) regulation of GHG emissions. See [State of West Virginia et al. v. U.S. Environmental Protection Agency et al.](#)

U.S. Appeals Court Upholds a Federal Order to Open Wholesale Markets

In July 2020, the D.C. Circuit upheld the Federal Energy Regulatory Commission's (FERC) Order 841, which could clear the way for transmission grid operators across the country to open their markets to energy storage. The decision is seen

GREENTECH

LEGAL IMPLICATIONS (CONT'D)

as a victory for the energy storage industry. See [*National Association of Regulatory Utility Commissioners v. Federal Energy Regulatory Commission*](#).

FERC Issues Order to Open Organized Wholesale Markets to Aggregations of Distributed Energy Resources

In September 2020, the FERC issued Order No. 2222 in an effort to promote competition in electric markets by allowing distributed energy resources (DERs) to compete on more equal footing with regional grid operators. FERC's Order No. 2222 enables DERs to participate in the capacity, energy, and ancillary service markets operated by regional transmission organizations (RTOs) and independent system operators (ISOs) alongside traditional resources by allowing entities to combine or aggregate DERs in order to satisfy minimum size and performance requirements. While FERC's [Order No. 2222](#) is currently in the [implementation stage](#), its impact on regional organized wholesale markets is expected to be significant.

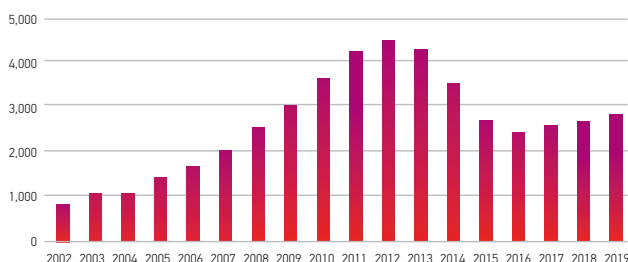
PATENT TRENDS AND OUTLOOK

Global Greentech Patent Filings Rising

The overall volume of international patent applications in key greentech indicator areas appears to be recovering after several years of declines starting in 2013, according to [data and analysis](#) from the World Intellectual Property Organization (WIPO). This timing suggests a link to the cleantech funding bust around the same time frame.

Further, the recent increase in sustainable technology funding, coupled with a stronger alignment of government policy

TOTAL RENEWABLE PATENTS FILED



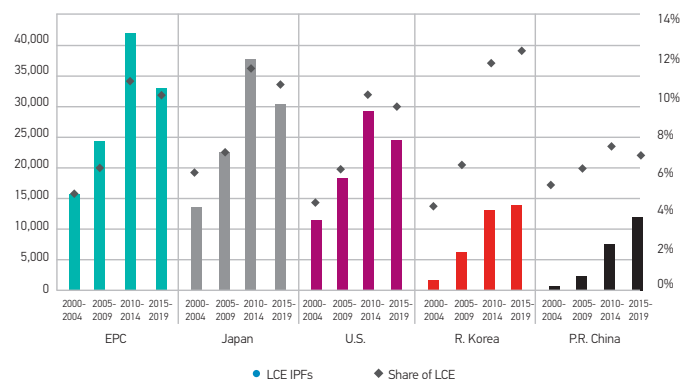
Source: [WIPO Magazine](#)

priorities, points to more robust years ahead for new greentech patent applications.

U.S. International Greentech Patent Activity Ranks Third Globally, Behind EU and Japan

Europe, Japan, and the United States dominate the global low-carbon energy (LCE) innovation landscape, together accounting for more than three-fourths of all international patent families (IPFs) generated from 2000 to 2019, according to a 2021 [report](#) by the IEA and European Patent Office (EPO).

GROWTH IN GREENTECH (LOW CARBON ENERGY INNOVATION) INTERNATIONAL PATENTS



Source: [European Patent Office](#)

Within the larger sphere of clean technology, patent analysis in the IEA and EPO report shows that leading areas of innovation by U.S. filers include:

- Bioenergy
- Efficient Energy Combustion
- Nuclear Energy
- Aviation
- Carbon Capture and Storage

In addition, a high share of international collaborations related to the development of clean technologies involve the United States and Europe and have the potential to accelerate technological progress. The IEA and EPO [report](#) indicates that international co-inventions have increased in the United States and most European countries and that there is a high share of co-invention in U.S. IPFs.

GREENTECH

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ABOUT US

Technology Transactions & Privacy | Greentech

We advise our greentech clients on numerous key issues including startup formation, founders issues, and raising capital. Our Intellectual Property attorneys help our greentech clients patent and protect their intellectual property. In addition to providing startup, corporate, and intellectual property counsel, we advise greentech clients on labor and human relations matters. Our Environment and Energy attorneys counsel public and private clients who are advancing scientific and technological responses to climate change. Our Energy Regulation and Policy attorneys help clients site and operate manufacturing plants as well as market and execute strategic partnerships and acquisitions.

Working across multiple practice groups, we counsel greentech clients on a variety of issues involving key sectors of greentech, including energy efficiency, renewables, alternative energy, transportation, and water.

2022 EMERGING TECHNOLOGY TRENDS

MARKET AND LEGAL INSIGHTS FOR INNOVATORS

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