

## The acceleration of climate change and mitigation technologies: Intellectual property trends in the renewable energy landscape

A REPORT BY CAMBRIDGE IP

### 1 minute read: key messages

- Patenting activity has increased in all four technology sectors analyzed (biofuels, solar thermal, solar PV, and wind).
- Innovation and patent filing rates in these technology sectors grew by 24% annually between 2006 and 2011 and outpaced the 6% global average increase in patent filings.
- The highest rate of technology investment is in the solar PV sector.
- China and the Republic of Korea have contributed most in recent years across all four technology areas.
- Over 30% of patents filed made use of the Patent Cooperation Treaty (PCT) system.
- Patent concentrations have decreased across three of the four patent landscapes (wind being the exception), reflecting greater globalization as well as higher competition between players from more countries.
- In solar PV, the top 20 technology owners are based in Asia.

## The Role of Climate Change and Mitigation Technologies (CCMTs)

Climate change is one of the biggest challenges of our time. Global greenhouse gas emissions, a main driver of climate change, continue to rise rapidly with observed carbon dioxide (CO<sub>2</sub>) concentration levels exceeding 400 parts per million as of May 2013, a record high in several hundred millennia.<sup>1</sup>

Since its inception, the United Nations Framework Convention on Climate Change (UNFCCC) has emphasized the key role of technology development and transfer in helping to stabilize greenhouse gas concentrations (Article 4.5 UNFCCC). For this to happen, a global adoption of climate change mitigation and adaptation technologies as well as policies that support the effective transfer of technologies are crucial. To this end, policy-makers and stakeholders need to be informed of the empirical evidence surrounding key CCMTs.

Patent publications around the world are an important source for structured and accurate information on inventors, technologies, innovation and technology ownership. Analysis of patent data relating to an industry or a specific technology can reveal important information about the origins of a technology, how a technology space is developing and how the composition of industry players has evolved. It can also identify the most important (commercially or scientifically) patent documents of a technology or industry space. The analysis of patent data can therefore inform both commercial decision-making and the formulation of effective public policy.

## Emerging Innovation: Technology Trends to Watch

### BIOFUEL

Starter material fermentation and fermenters used in the production of biofuels; increased efficiency in production process; fuel-from waste; and algae-related applications.

### SOLAR THERMAL

Coating, manufacturing and resilience of glass material (especially as they relate to heat exchange systems); the development of control systems relating to tracking; and energy storage technology integration.

### SOLAR PV

Materials, manufacturing processes and design improvements of silicon based PV systems; flexible three-dimensional panels; and nano-materials.

### WIND ENERGY

Turbine-based solutions in software and control systems; system integrators with other energy sources; offshore wind innovations focused on scaling up the size of turbines and increasing durability.

## The Growth of CCMTs

Over the past decade, many CCMTs have experienced increased levels of innovation and cost reductions, a notable example being the cost reductions witnessed in the solar photovoltaic (PV) market since 2009.<sup>2</sup> When novel and improved CCMTs are combined with appropriate policy and financing, they have the potential to provide global and national climate change benefits, including reductions in the carbon intensity of growth in developing economies, achievements in meeting greenhouse gas reduction targets and job creation.<sup>3</sup> Total investment in renewable energy and fuels was

\$244 billion in 2012 alone.<sup>4</sup> This represents a 12% decrease from 2011's record figure of \$279 billion. Nonetheless, 2012 still ranks as the second-highest year ever for investment and it is still up 8% from the previous all-time high in 2010. Speculation into the drivers suggest that uncertainty in policy in developed markets played a key role, as well as the need for electricity generating capacity in these markets.

In developing economies, total investment into renewable energy in 2012, however, was up 19% from 2011, accounting for \$112 billion in investment, the highest to date. Developing economies thus accounted for 46% of total investments into renewable energy. In 2012, the US and China were the countries with the highest level of investment in this sector at \$36 billion and \$67 billion, respectively.

While the aggregate global figures show a recent decrease in investments, the overall volume of investment remains high in the renewable sector with developing markets playing an increasingly central role. The large scale of investment in renewables is driving R&D and innovation and is reflected in the higher patent filing rates.

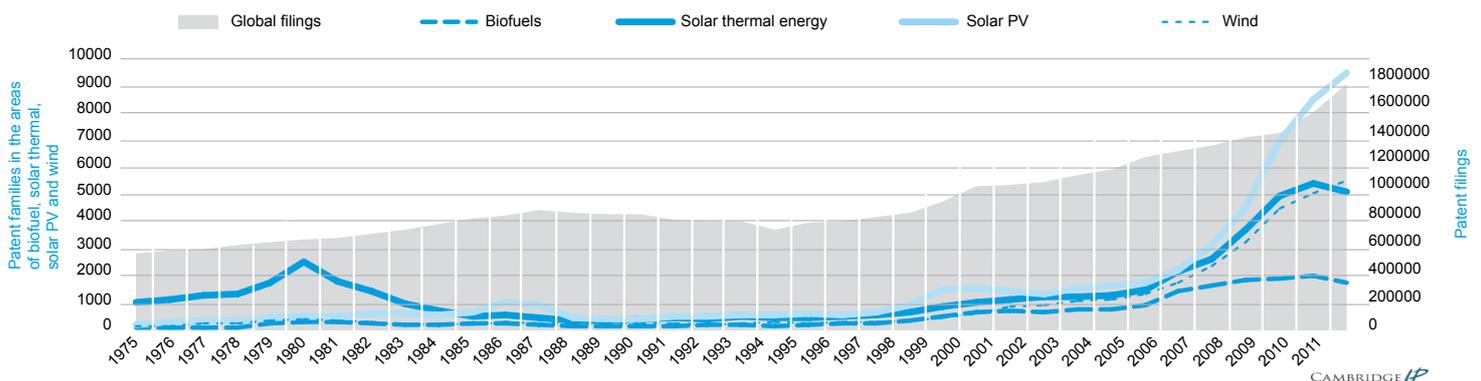
Record numbers of patents have been filed globally in recent years. Indeed, 2011 marked the first time that patent applications filed through the PCT exceeded the 2 million mark<sup>5</sup> with 182,000 filed in 2011 alone<sup>6</sup> and over 200,000 in 2013.<sup>7</sup> Patent filings around CCMTs are growing at a faster rate than the global average, indicating the high pace of commercial innovation in CCMTs. Table 1 shows the average annual growth rate of patent filings in the four CCMTs.

## What does the Evidence Suggest?

### Significant increases in patent filings

Renewable energy technologies experienced relatively low patenting rates until the late 1990s when filing rates started to increase. For all four technology areas, the rate of filings began to increase strikingly in 2006 (Figure 1).

Figure 1: Global patent application trends for selected CCMTs: 1975 - 2011



**Table 1: Global Patent Filing Rates**

(see Box for a description of the technology areas)

TECHNOLOGY CLASSIFICATION	AVERAGE ANNUAL GROWTH RATE 1975-2005	AVERAGE ANNUAL GROWTH RATE 2006-2011
Biofuels	9%	13%
Solar thermal	3%	24%
Solar PV	10%	22%
Wind	9%	27%
Global patent filings	3%	6%

The growth in patenting rates in the respective technology fields is likely a combination of the positive impact of policies and response to market conditions, including increased levels of R&D investment, shifts in policy incentives, such as feed-in-tariffs, as well as technological advances, such as cost reductions in manufacturing.

#### *Shifting technology ownership*

There is evidence of players from developing and emerging economies becoming increasingly active in commercial innovation in the noted focus areas, as well as evidence of major global corporations deploying innovations in emerging economies. Within each technology focus area the patent literature provides valuable insights around industry structure, market drivers and supply chains.

- One striking feature about the top patenting entities in the biofuels technology space is the large number of universities and research institutions. Over 50% of the top 20 technology owners are connected to a research institute or university. This number is especially high in comparison to the other technology landscapes analyzed in this report, as they have at most a quarter, or in the case of wind energy, no university or research institutes in the top 20 technology owners. Chinese universities and research institutes (including one corporate-research partnership) account for 11 of the top 20 technology owners, nine of which are public institutions.
- In solar thermal, for the period 2006 to 2011, sixteen of the top twenty technology owners are new entrants. Half of the new entrants to the ranking are from China, while five of the top 20 are from Germany, which is still a major player in this field. Solar thermal is an industry in which the top technology owners will not necessarily reflect the top operators of solar thermal power generation plants. This is due to the large-scale investment and resource capacity necessary to own and operate a solar thermal plant. Often operators will be aggregators of technologies and specialize in large scale operation and maintenance (O&M).
- Japanese companies continue to play a prominent role in the solar PV patent landscape. Seven out of

the top ten technology owners are Japanese based companies. Additionally, large corporate players in the Republic of Korea appear to be increasing their interests and investments in solar PV, as evidenced by the ascent of LG, Samsung and Hyundai in the solar PV patent landscape.

- Wind energy is the only space that does not contain any universities or research institutions among the top twenty technology owners. A contributing factor could be the relative maturity and established technological systems within the technology space. Wind energy is also notable in that it features a high proportion of technology owners from Europe, whereas the other technology landscapes feature only 0-15% European based ownership.

#### *Going global: Patent filings by geography*

Analysis of trends in patent filing jurisdictions can provide an indication of where innovation is occurring, as well as current and potential markets for technology to be sold, licensed or produced.

The PCT system administered by WIPO provides patent applicants intending to file in multiple jurisdictions a simplified and cost-effective route for doing so. There has been a striking rise in the use of the PCT system across all four of the focus areas. This is likely indicative of increasingly globalized markets and demand for climate change and mitigation technologies.

There is also a strong indication from the data of the increasing influence of the Asian market. In particular, China accounts for the highest percentage of patent filings in three of the four CCMT patent landscapes for the period of 2006–2011 (biofuels, solar thermal and solar PV). The contribution from China is particularly strong for solar thermal technologies and accounts for around 55% of the Office of First Filing (OFF) applications from 2006–2011.

#### *Diverse industry structures and drivers*

CCMTs are at different stages of maturity with a range of industry structures and drivers. Wind energy is widely considered to be one of the most established sectors for renewable energy. It has the highest intellectual property ownership concentration, and sees the largest volume of granted patents.

Comparatively, the biomass patenting space is characterized by a relatively low IP ownership concentration, disperse IP ownership and the presence of numerous universities as assignees. Compared with the other CCMTs focus areas, biomass is widely considered to have a wider scope for early stage research and development opportunities.

## Key Implications & Considerations for Policy & Policymakers

The following key implications and considerations for policy and policymakers are intended as starting points for reflection, to be adapted to specific needs and circumstances.

1. The research indicates significantly increased volumes of patent activity in biofuels, solar thermal, solar PV and wind energy since 2006. This could give rise to difficulties navigating relevant patent landscapes, which are increasingly crowded and international. Patent landscapes provide policy-makers a reliable and empirically-based resource of information on climate change and mitigation technologies. Comprehensive and up-to-date patent mapping that make explicit features from emerging technology landscapes will continue to provide evidence-based insight into the debate on the role of technology innovation for a low carbon pathway.
2. A greater use of the PCT system and the European Patent Organization (EPO), as well as higher participation from BRIC countries and other emerging economies in CCMT patent landscapes can be observed. In recent years, most patent applications have been filed in both China and the Republic of Korea across all four focus CCMTs. This rise in international filings indicates that market penetration and manufacturing are an increasingly globalized pursuit.
3. Greater investment into more diverse markets could also indicate an enhanced capacity for technological solutions to be deployed on a global scale. This presents an opportunity to create knowledge transfer networks that share pathways to development.
4. Global engagement in discussions on the role of technology innovation policy and transfer conditions has occupied an increasingly central role. Supporting international dialogue around IP related issues and supporting technology transfer mechanisms, such as UNFCCC's Climate Technology Centres and Network (CTCN) and WIPO GREEN, will remain important.
5. Technology will play an important role in solving the global challenge of climate change. Technology intelligence and the provision of patent-based research can assist in the development and deployment of climate change and mitigation technologies in a number of ways. The identification of emerging trends in technology can allow for appropriate investment mechanisms to be instituted. Opportunities for innovative partnerships can be identified by highlighting areas of technological similarity and overlap. Information on geography of filings and the innovation capacity in different areas can serve to accelerate technology diffusion between markets and help to identify knowledge networks and technological strengths. This, in turn, can have an impact on technology transfer between economies.

- 1 UNEP News Centre, 2013. Observed Concentrations of CO<sub>2</sub> Cross 400 parts per million Threshold at Several Global Atmosphere Watch Stations' United Nations Environmental Programme. [Online] Available at: [ow.ly/uMU6N](http://ow.ly/uMU6N)
- 2 Natureo Finance, 2012. CIGS Thin-film Solar. [Online] Available at: [ow.ly/uMVNP](http://ow.ly/uMVNP)
- 3 UNEP, 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. [Online] Available at: [ow.ly/xvNcf](http://ow.ly/xvNcf)
- 4 Frankfurt School-UNEP Centre, 2013. Global Trends in Renewable Energy Investment 2013. [Online] Available at: [ow.ly/vnpKJ](http://ow.ly/vnpKJ)
- 5 WIPO, 2011. International Patent System Marks Two Millionth Filing – U.S. Mobile Technology Innovator, Qualcomm, files Landmark Application. [Online] Available at: [ow.ly/xvNnd](http://ow.ly/xvNnd)
- 6 PCT, 2013. Statistics of the PCT System. [Online] Available at: [ow.ly/uMVQu](http://ow.ly/uMVQu)
- 7 WIPO, 2014. US and China Drive International Patent Filing Growth in Record-Setting Year. [Online] Available at: [ow.ly/uMVS9](http://ow.ly/uMVS9)

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Citation: CambridgeIP, 2014. *The acceleration of climate change and mitigation technologies: Intellectual property trends in the renewable energy landscape*. Global Challenges Brief, WIPO: Geneva. [Online] [www.wipo.int/globalchallenges](http://www.wipo.int/globalchallenges)

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