

# CambridgeIP

WTO Regional Workshop

***Intellectual Property and its Role in the  
Generation and Diffusion of Green  
Technologies***

11 to 13 November 2014

Hong Kong, China



CAMBRIDGE *IP*

DISCOVER *IP*

- Technologies to help address climate change adaptation and mitigation challenges exist. The time taken to mass deployment of leading edge technologies is a concern: Our research shows that it takes between 19 to 30 years for top cited low carbon technologies to reach the mass adoption phase
- Patents can be both barriers to and enablers of technology development and deployment - how can we mitigate patent related barriers and take advantage of the enabling aspects of the patent system?
  - The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations. (TRIPS, Article 7)
- Not all technologies are patented, many relevant patents have expired and many patented technologies are not patented widely around the world – this makes a large range of technologies available for deployment *in principle*, although there can be many barriers other than patents

“The intellectual property regime can act as an incentive to the innovator, but the granting of the property right can also slow the dissemination of technological progress and prohibit others from building on this innovation. Managing this balance is an important challenge for policymakers.”

The Stern Review, Chapter 16, page 369

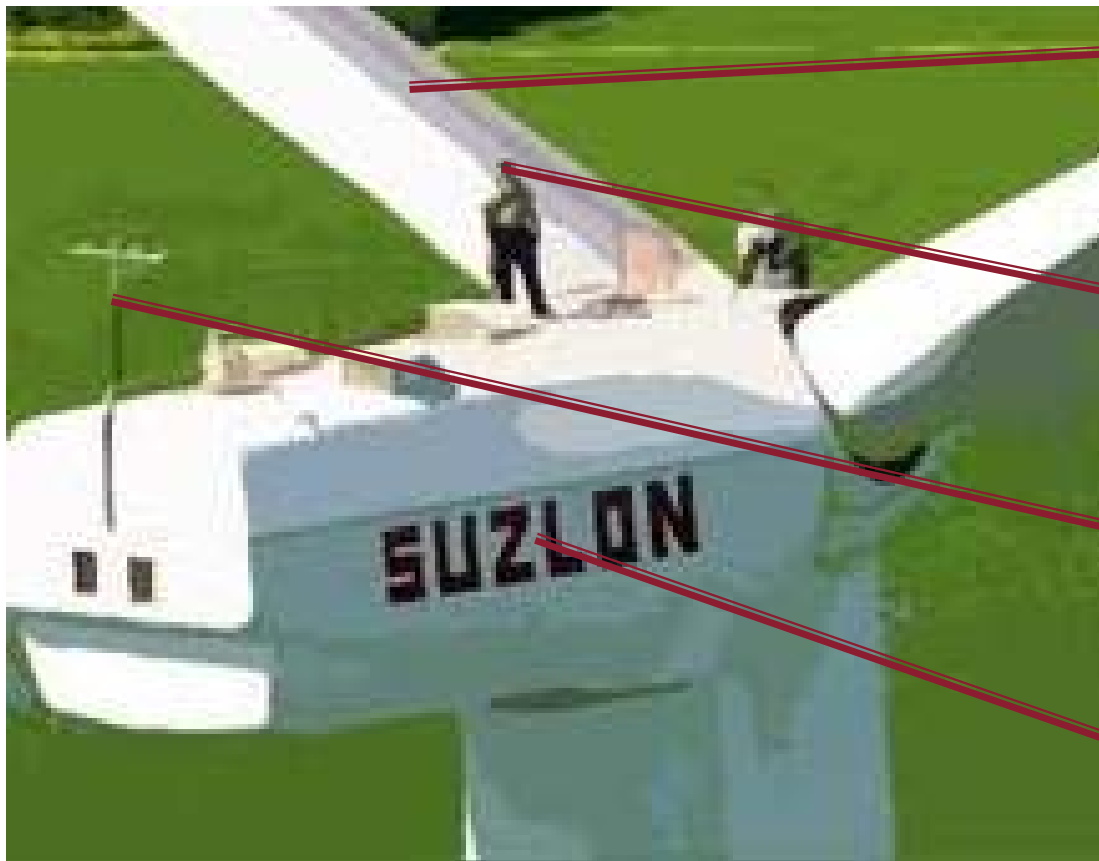
Valuing IP – can we decide what the IP is worth?

- Costs approach (using anticipated costs of maintenance & defense of IP over its lifetime as basis for calculations of the value of that IP); Econometric approaches (including Productivity; Profitability/Market Value; Employment & Wage levels)

Patenting rates are significant with over 70 Million patents and patent applications worldwide

- Relative patenting rates vary from industry to industry
- Not all technology is patented: There are other forms of IP protection
- Many patents never result in commercially successful products, and a relatively high proportion of patents are abandoned before their term expires: Sound business models and good commercial returns can be more important than patented IP

A modern and complex technology product is protected by different type of Intellectual Property



**Patents:** ability to prevent others from using your technology  
e.g. patents around turbine transmission systems

**Trade Secrets:** non-disclosed and commercially valuable information  
e.g. production or installation methods

**Copyright:** protecting the form of expression  
e.g. Control software written by/on behalf of Suzlon

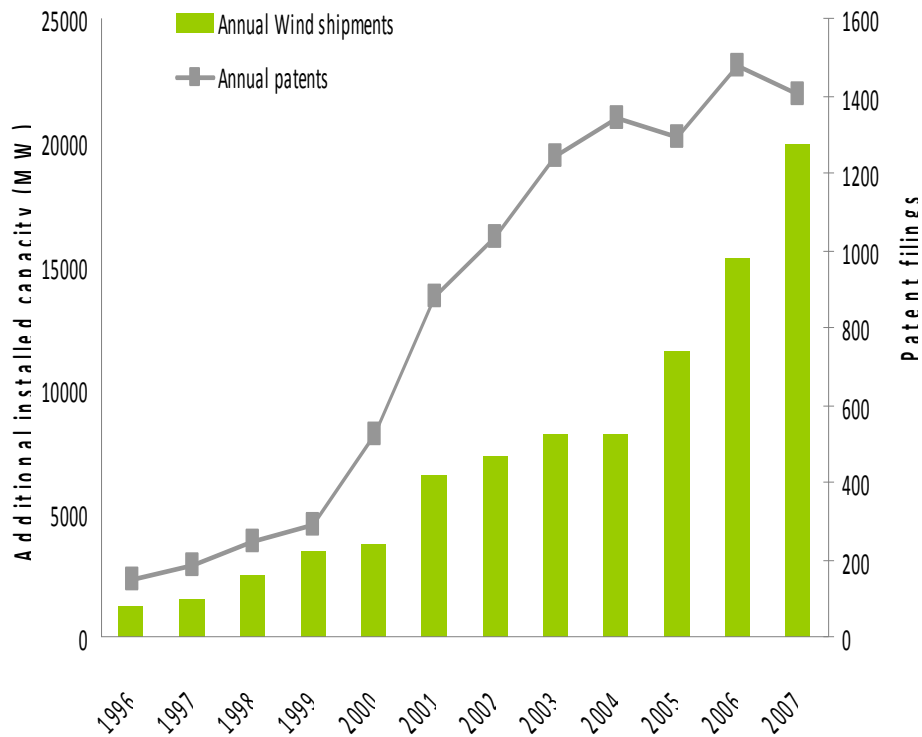
**Trade Mark:** protection of the word/symbol denoting the origin of a good

- Climate Change and Mitigation Technologies ('CCMTs') are diverse, and the IP ownership and IP models spanning the range of CCMTs are similarly diverse
- Markets and manufacturing locations for CCMTs are increasingly global, and patent activity reflects this globalization
- Patent activity levels around CCMTs are rising, with dramatic increases in the past few years in the key focus CCMT areas we have studied with WIPO
- Within this context, ASPAC countries have an important role in CCMT development and deployment, and many ASPAC nations are increasingly significant patent holders

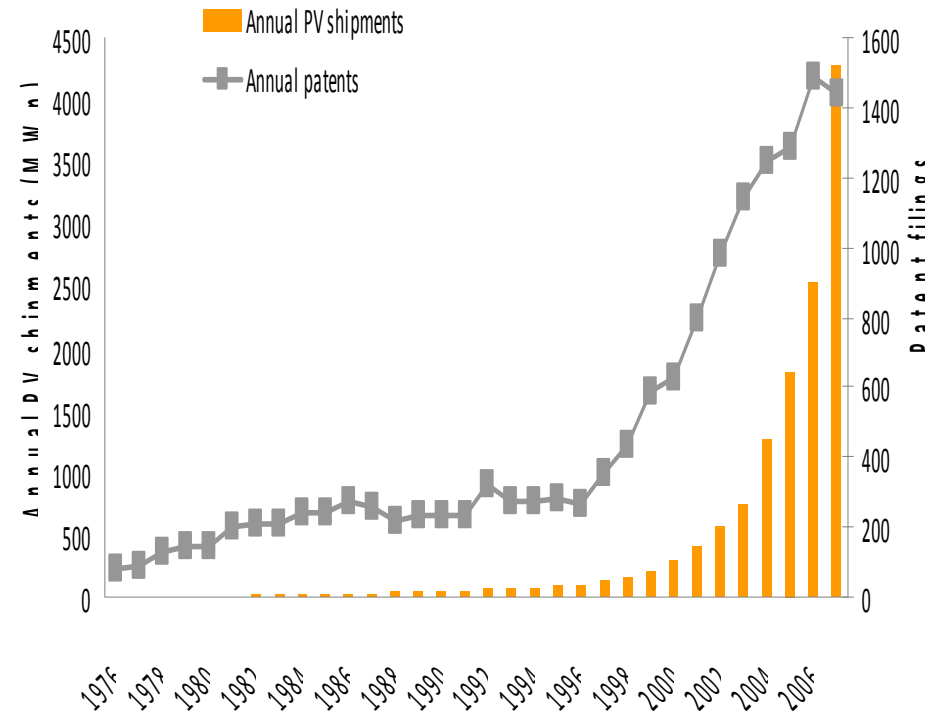
- Corporations deploy a range of Intellectual Property Rights (IPR) strategies.
- To briefly address just one IPR strategy – out-licensing, approaches to out-licensing include:
  - *Controlled licensing*: Technology owner controls use and any cascade of use and licensing
  - *Cross-licensing*: Alliances are formed where allies can rely on each other's IP. Often linked to standards, which can govern future IP licensing activities.
  - *Divestiture licensing*: Technology owner sells rights to recoup investments, may include spin-out or start-up company licensing
  - *Pure-play licensing*: Technology owner does not manufacture or distribute, rather technologies are designed, prototyped and licensed to a network of third party out-licensors, manufacturers, distributors

# Policy works. Patenting has generally grown with deployment rate

## Wind



## Solar PV

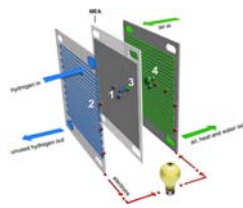




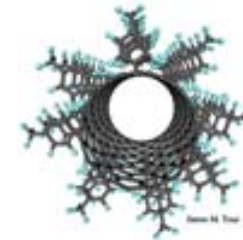
# Diverse Low Carbon & Energy Focus Areas



Wind Energy Systems



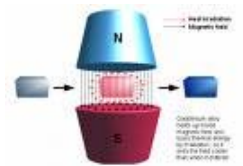
Fuel Cells



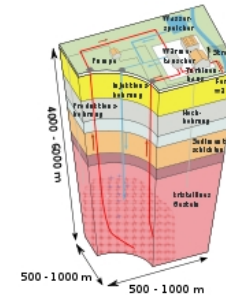
Nano Devices & Materials



Biomass



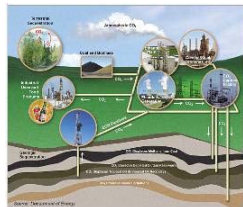
Advanced Refrigeration



GeoThermal Energy Systems



Photovoltaic & Component Technologies



Clean Coal  
Carbon Capture  
CO2-EOR



Refineries,  
Power Gen,  
Co-Gen.



Concentrated Solar & Other Energy Storage Systems



Marine Transport



Smart Grid



Consortia & Research Alliances



## Comment

CambridgeIP completed a report with WIPO, analysing patent activity in key CCMT focus areas to inform policy discussions

The CCMT patent landscapes analysed in our report are Biofuels; Solar thermal; Solar PV; and Wind.

# Climate Change Mitigation Technologies

Biofuels



Solar Thermal



Solar PV



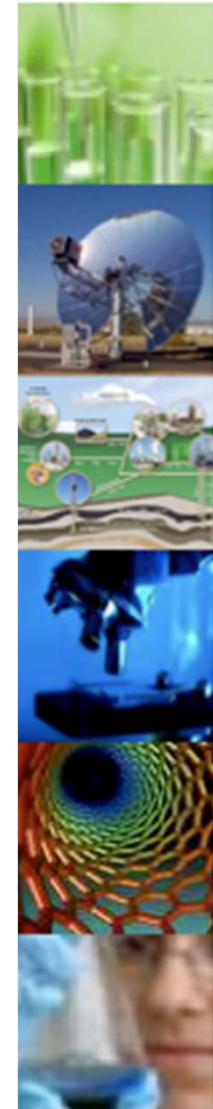
Wind



Helm, S., Tannock, Q., and Iliev, I., 2014 renewable Energy Technology: Evolution and Policy Implications – Evidence from patent Literature. Global Challenges Report, WIPO: Geneva.

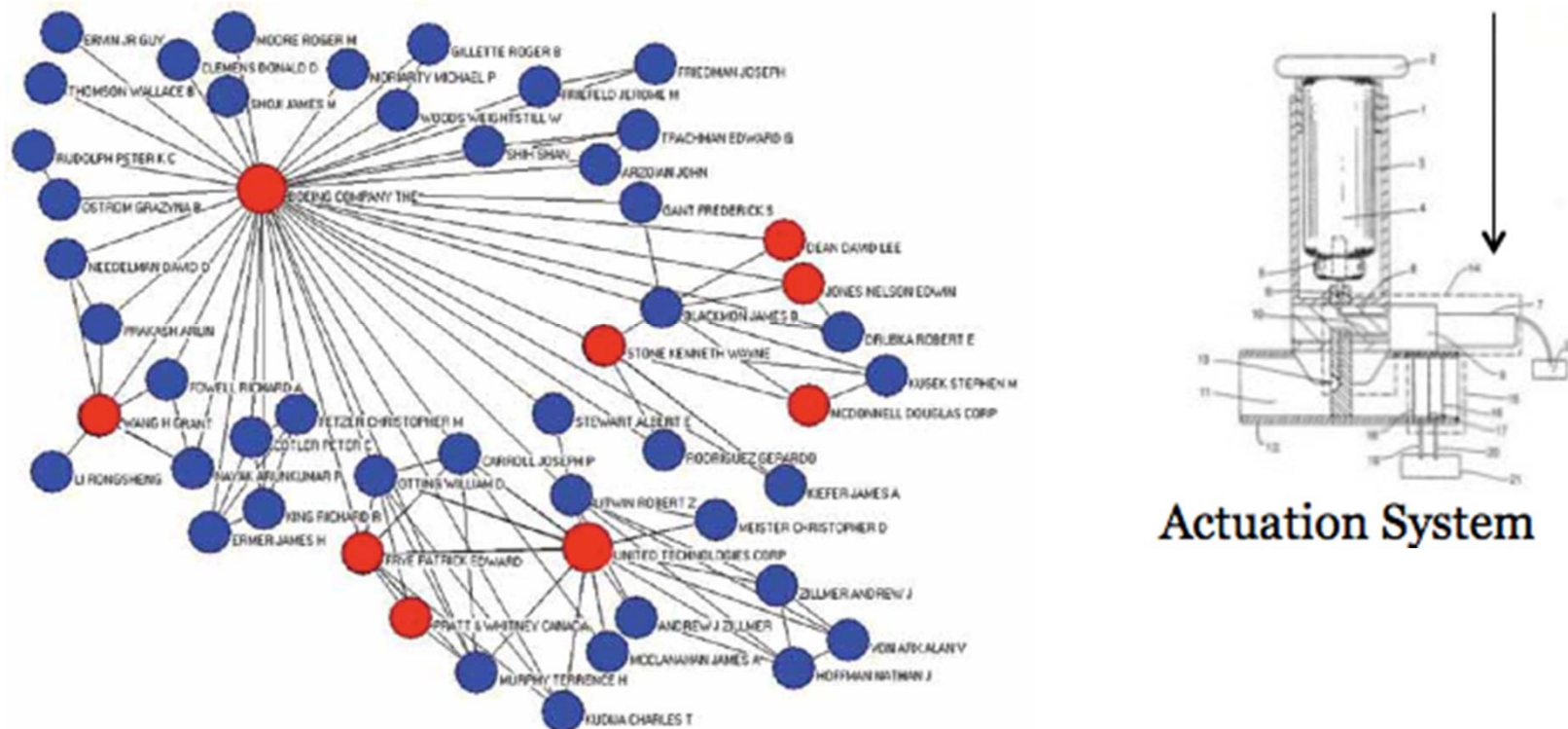
## The patent system represents a significant global technological library

- Patents as data are:
  - Structured
  - Comparable
  - Objective
  - Information rich
- Multiple patent data sources are available (an opportunity and a challenge!), e.g:
  - USPTO
  - Espace.net
  - Google Patents
  - Specialists like CambridgeIP



- Patents provide
  - Specifications of technologies, and their uses, with technical diagrams
  - Information on the relationships between technologies, and the R&D relationships underpinning developments and their intensity

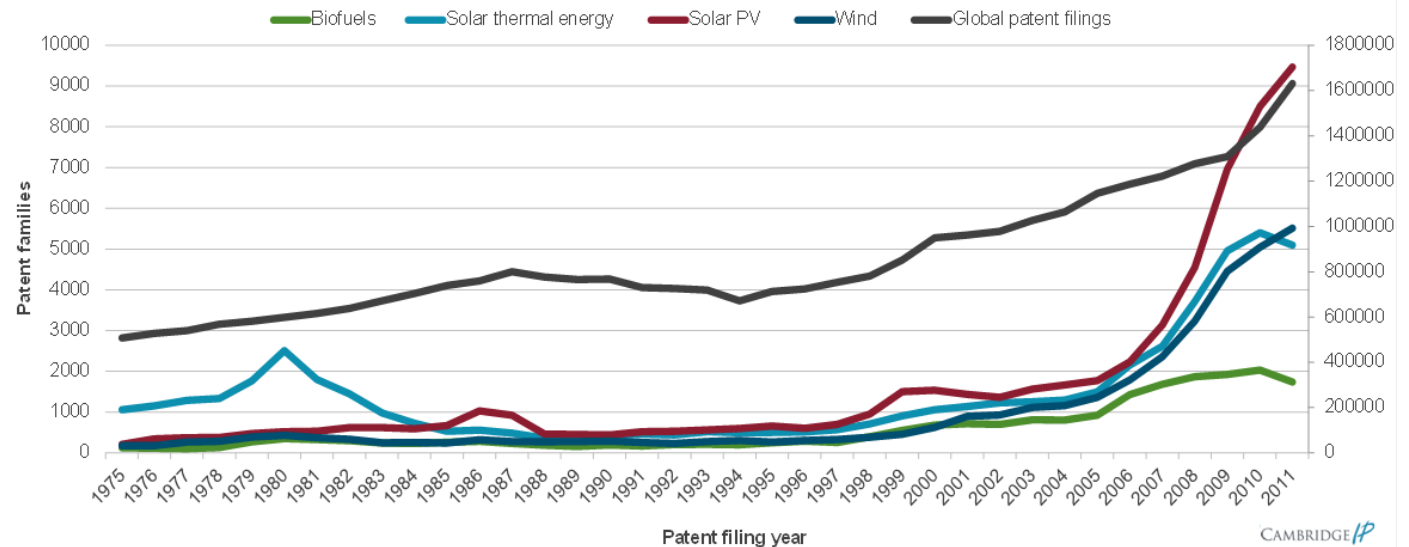
Figure 4.8: Linkages of Boeing in concentrated solar power



## CambridgeIP Insight

- The focus CCMTs experienced relatively low patenting rates until the late 1990s
- We see a particularly striking increase in filings rates starting in 2006 in all four of the focus areas. The combined average growth rate across the four areas for the period of 2006 – 2011 is 24%, far outpacing the global average for the same period of 6%
- Of the four CCMT patent landscapes solar PV has seen the highest average annual growth rates in 2006 - 2011 with an average annual growth rate of 33%. Solar PV is followed by wind energy at 24%, solar thermal at 24% and lastly biofuels with 13%.

Global patent application trends for selected CCMTs:  
1975 - 2011

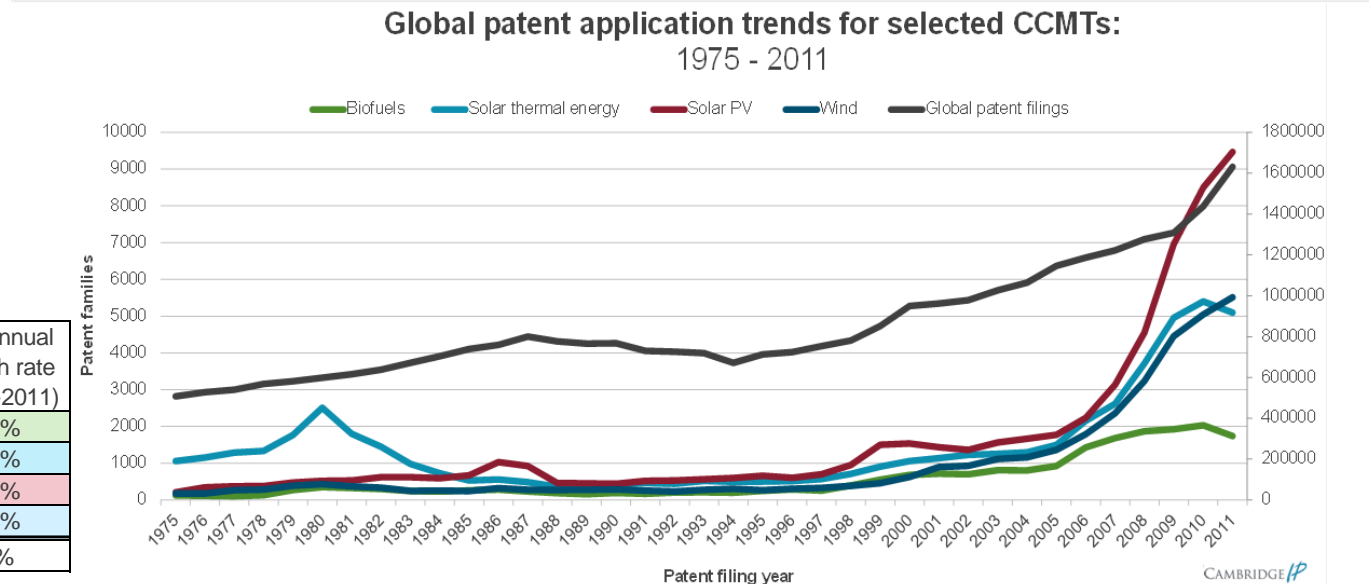
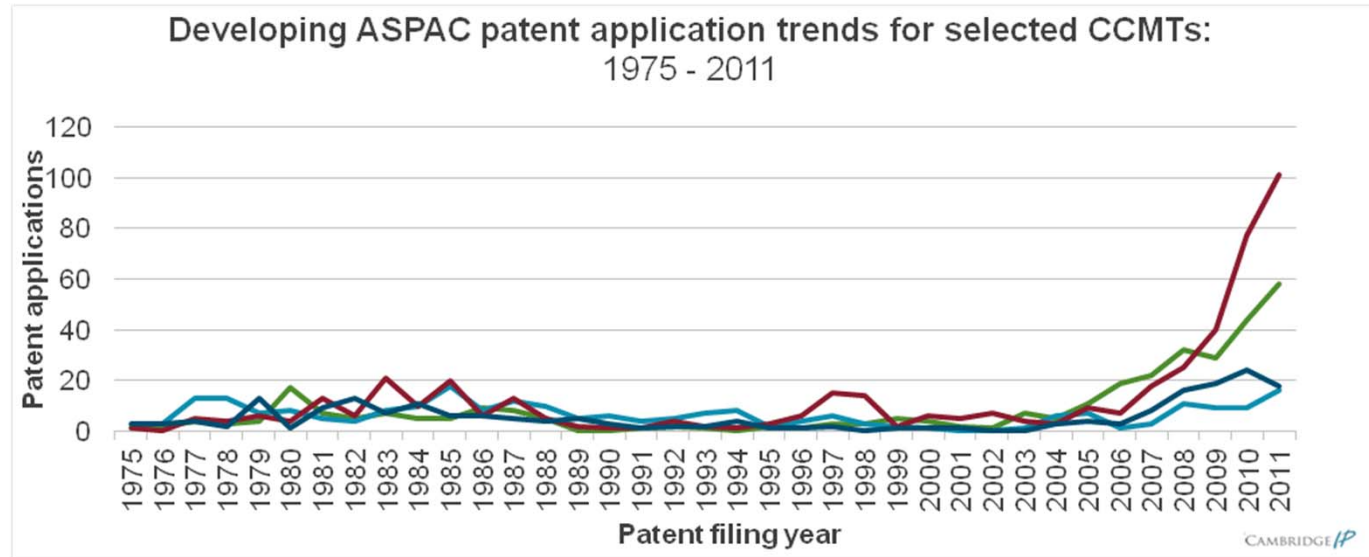


Technology Classification	Avg annual growth rate (1975-2005)	Avg annual growth rate (2006-2011)
Biofuels	9%	13%
Solar thermal energy	3%	24%
Solar PV	10%	33%
Wind	9%	27%
Global patent filings	3%	6%

# CCMT patent application trends in 'developing ASPAC' countries

## CambridgeIP Insight

- With the exception of Solar PV, which rises briefly in the late 1990's, developing ASPAC countries experienced relatively low patenting rates until the late mid-2000s
- As for the global picture, we see a particularly striking increase in filings rates starting in 2006 in all four of the focus areas.
- In developing ASPAC the biofuels space grows more rapidly, Wind and Solar Thermal appear to grow at a slightly lower rate, than the relevant global trends.



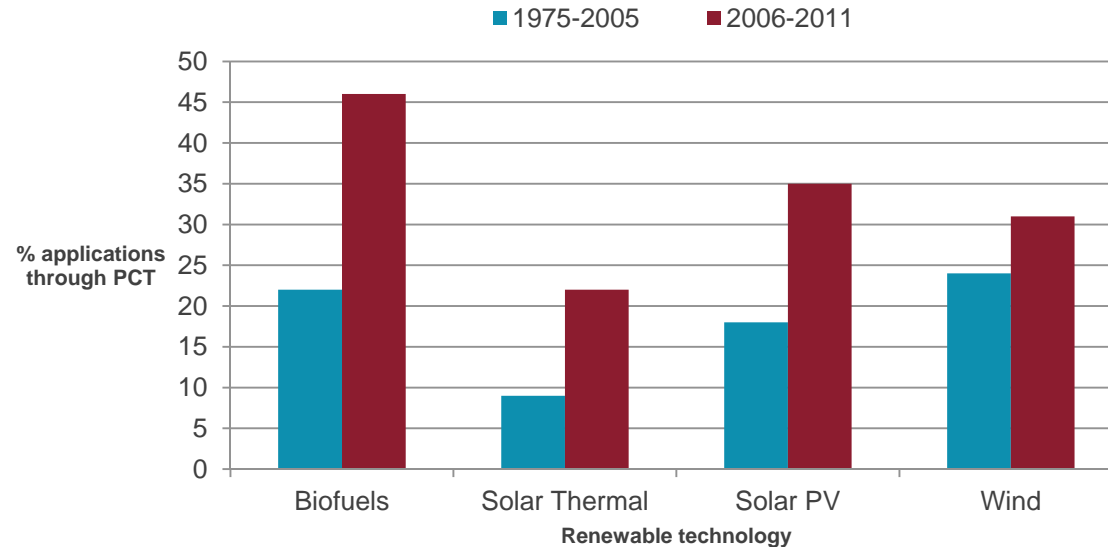
Technology Classification	Avg annual growth rate (1975-2005)	Avg annual growth rate (2006-2011)
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Solar thermal energy	3%	24%
Solar PV	10%	33%
Wind	9%	27%
Global patent filings	3%	6%

# Growing international markets for CCMTs: PCT applications

## CambridgeIP Insight

- There is evidence in the patent literature of growing international markets for the focus CCMTs.
- Since 2006 over 30% of the patents filed in the four CCMT areas are PCT patents, filed through the system administered by WIPO

% of patent applications filed through PCT system



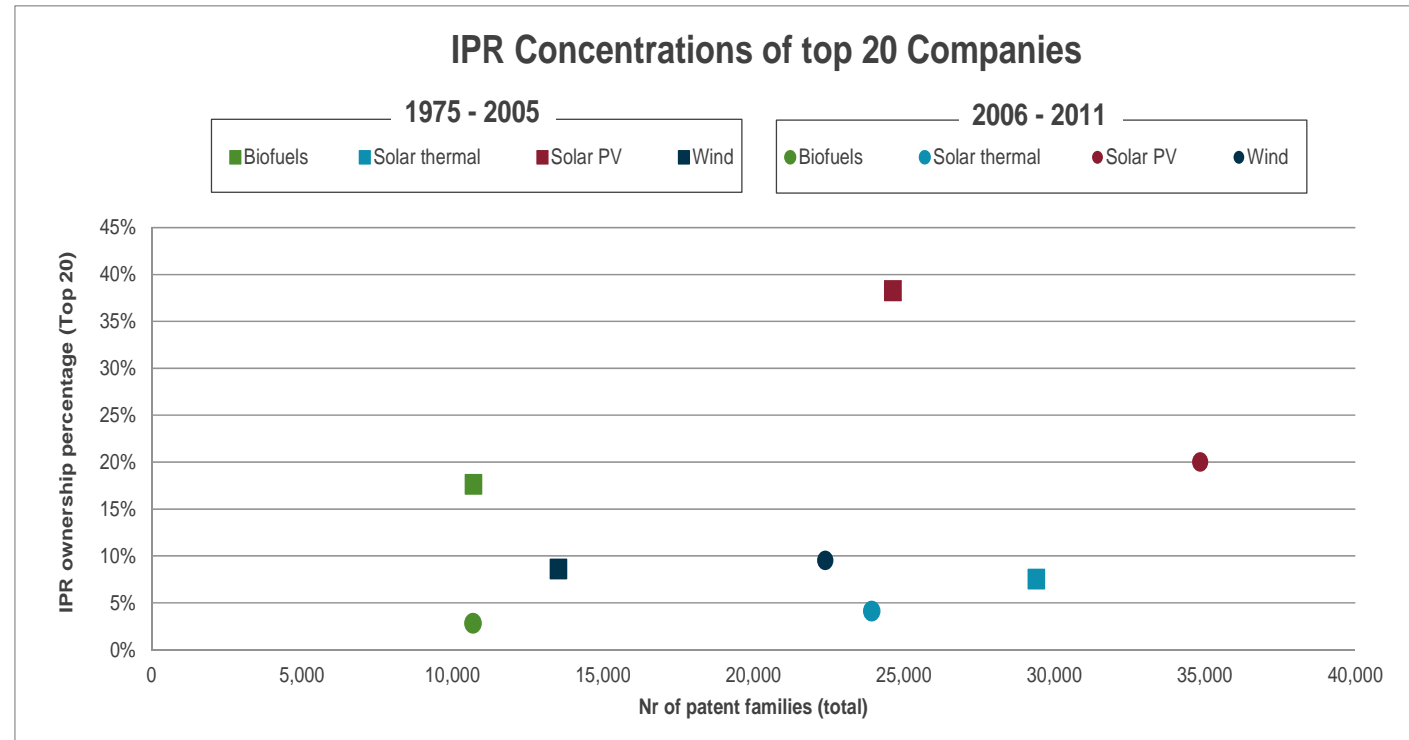
Patent filing period	Biofuels	Solar Thermal	Solar PV	Wind
<b>1975 - 2005</b>				
% of patent applications filed through PCT system	22%	9%	18%	24%
<b>2006 - 2011</b>				
% of patent applications filed through PCT system	46%	22%	35%	31%



# IPR concentration: CCMT top patent assignees globally

## CambridgeIP Insight

- Intellectual Property Right (IPR) concentrations assess the concentration of patent ownership in a patent landscape.
- In the period 2006 – 2011 IPR concentration decreased across all four patent landscapes, with the exception of wind.
- This shift is perhaps indicative of increased globalisation and increased competition with more players from more countries around the world now becoming patent active in the relevant technology areas.





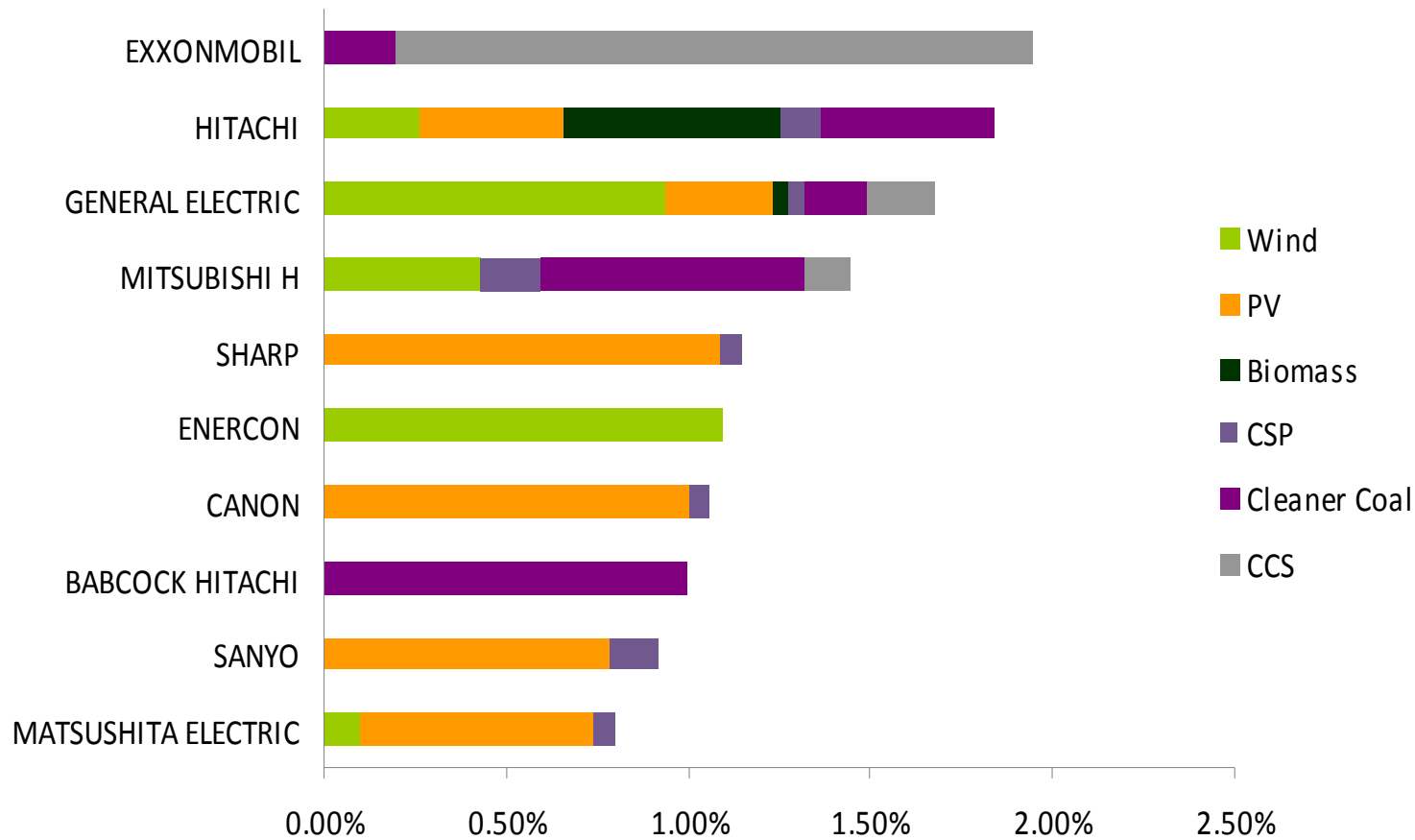
## CambridgeIP Insight

- Identification of technology owners and the emerging technological advances from the patent literature can highlight areas of industrial investment and innovation.
- Solar PV noticeably accounts for a majority of the technology owners listed. It is important to emphasise that IP strategies and patent filing strategies differ significantly between companies and across industries.

Table : Rank of top 20 technology owners (multiple CCMTs)

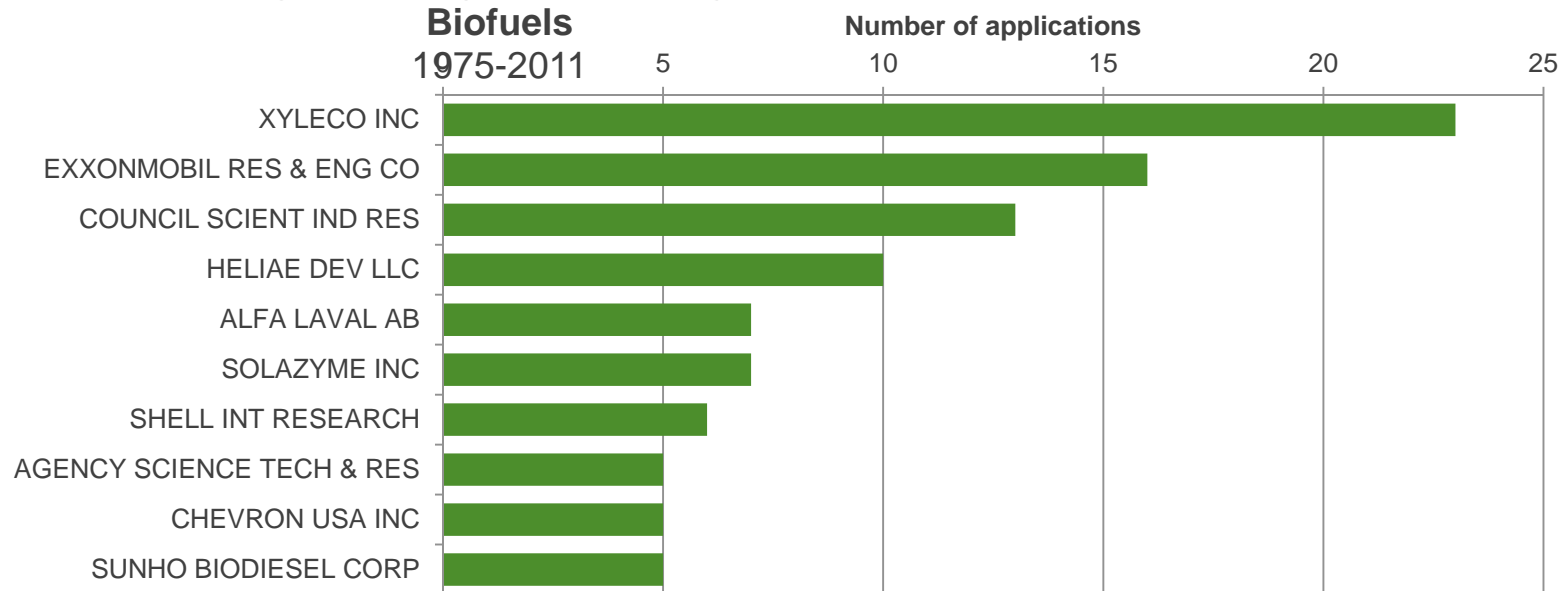
Rank 2006 - 2011	Technology Owners	Country of Company HQ	Technology area
1	LG	Republic of Korea	SolarPV
2	Mitsubishi	Japan	SolarPV
3	General Electric	USA	Wind
4	Sharp KK	Japan	SolarPV
5	Panasonic	Japan	SolarPV
6	Samsung	Republic of Korea	SolarPV
7	Siemens AG	Germany	Wind
8	Mitsubishi	Japan	Wind
9	Kyocera Corp	Japan	SolarPV
10	Konica Minolta	Japan	SolarPV
11	Fujifilm Corp	Japan	SolarPV
12	Hitachi	Japan	SolarPV
13	Vestas Wind Sys As	Denmark	Wind
14	Hyundai	Republic of Korea	SolarPV
15	Sumitomo	Japan	SolarPV
16	Toyota	Japan	SolarPV
17	Industrial Technology Research Institute	China	SolarPV
18	Sony Corp	Japan	SolarPV
19	Dainippon Printing Co Ltd	Japan	SolarPV
20	Suzlon Energy (REpower Systems)	India (Germany)	Wind

# High-carbon companies control some of the key knowledge assets underpinning the low carbon economy



# Biofuels in developing ASPAC: Top patent assignees

## Top assignees filing in developing ASPAC:



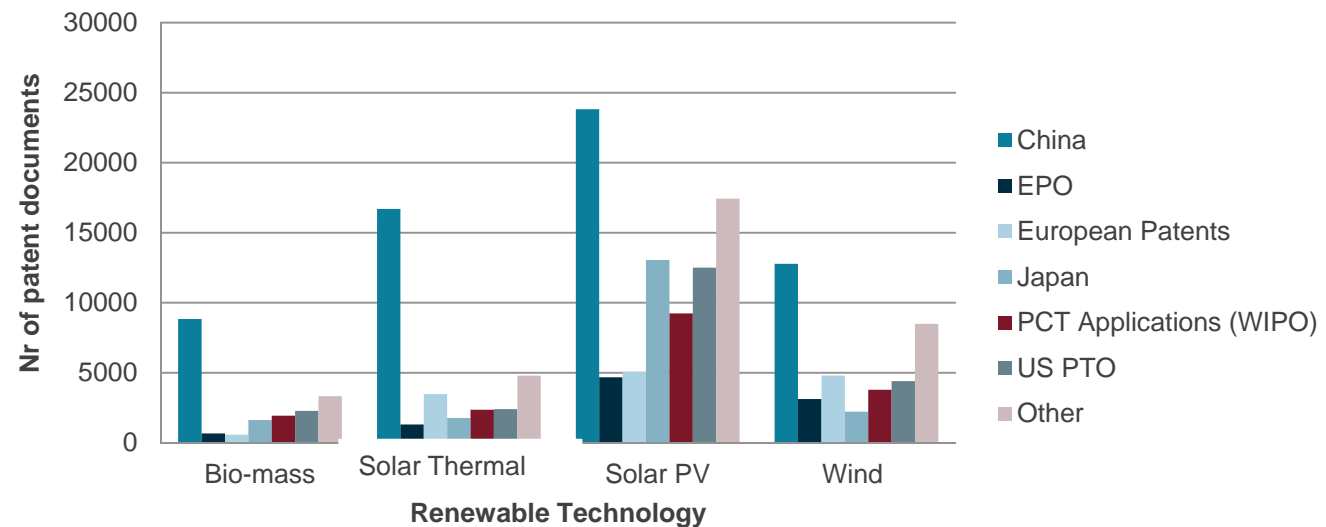
## CambridgeIP Insight

- Earlier we highlighted strong growth in patent activity around biofuels in developing ASPAC countries
- This slide shows the top biofuels patent owners by numbers of patents filed in developing ASPAC countries
- The top 10 list includes companies (both major oil and gas companies, and smaller technology development companies) and research institutes.
- There are a relatively large number of USA based companies in the list. India based research institute CSIR has a particularly strong showing

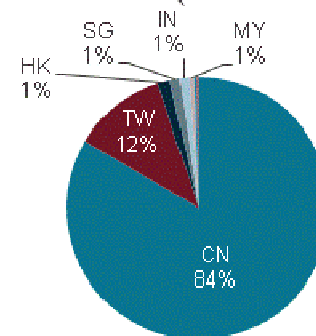
## CambridgeIP Insight

- The breakdown of filing geographies across the renewable energy technologies shows the relative strength of Japan for solar PV compared to the other fields.
- China can be seen to dominate filing geography across all technology areas.
- China's high level of patent activity across the four CCMT areas can be seen when we consider ASPAC as a whole.
- China accounts for 84% of all ASPAC patent applications across Bio-mass, Solar Thermal, Solar PV and Wind CCMT areas.

## Renewable Energy Technologies: Geography of patent filings for 2006-Present



## All ASPAC patent applications: Office of filing (1975 - 2011)



## Recommendation

- Our research indicates significantly increased volumes of patent activity in biofuels, solar thermal, solar PV and wind energy since around 2006.
- This could give rise to difficulties navigating relevant patent landscapes, which are increasingly crowded and international.
- **Well crafted and regularly updated patent mapping work, to make features of individual landscapes explicit may be required.**

## Patent activity levels are rising:

- The dramatic increase in patent filings in the focus CCMTs in recent years is a clear indication of increased commercial interest and innovation in these renewable energy technology solutions.

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- Patent activity within biofuels, solar thermal, solar PV and wind energy have all increased significantly. It is particularly striking that the volume of patents filed in these CCMTs in the five years 2006 – 2011 exceeds the volume of patents filed in these areas in the previous 30 years.

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- The average annual growth rate of patent filings in each of the focus CCMTs exceeds the global average for all technologies. The combined average growth rate in numbers of patent filings in Biofuels, Solar Thermal, Solar PV and Wind energy in the period 2006 – 2011 is 24%. While the global average for all technologies in the same period is 6%.

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- Within the four CCMT's solar PV has the highest number of patent filings; followed by solar thermal, wind energy and biofuels.

## Recommendation

- Patent activity around these four CCMTs to protect markets and manufacturing is increasingly global.
- The participation of BRIC and other emerging economies in the CCMT patent landscapes is increasingly significant.
- **Supporting international dialogue around IP related issues and supporting technology transfer mechanisms, such as WIPO GREEN, will remain important.**

## Markets and manufacturing locations are increasingly global:

- We observe a substantial rise in the number of patents applications filed in both PR China and the Republic of Korea in recent years across all four focus CCMTs.

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- We additionally observe increasing use of both the EPO and PCT systems, which is likely a reflection of an ever increasing global market for the CCMTs. There has been a noticeable shift from patents filed in a single European jurisdiction to the use of the EPO as a clearinghouse to file in multiple European jurisdictions. We also find that since 2006 over 30% of the patents filed in the four CCMT areas are PCT patents, filed through the system administered by WIPO.

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- IPR concentrations decreased across all four patent landscapes, with the exception of wind. This shift could be a further indicator of increased globalisation and increased competition with more players from more countries actively patenting.

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## Recommendation

- The patent activity we observe comes from a very diverse range of player types including major corporations, SMEs, research institutes and universities.

- Each CCMT area will require its own set of policies and support mechanisms, carefully crafted to meet the diverse individual requirements of each area.**

## The CCMT areas are diverse:

- The composition of technology ownership varies between the four CCMTs. Notably biofuels contains high proportion (over 50%) of universities and research institutions in the top 20 technology owners assessed by volume of patents. The other technology landscapes analysed in this report, as have at most a quarter (solar thermal), or (in the case of wind energy), no university or research institutes in the top 20 technology owners. Solar PV differs from the other focus CCMTs in that all of the top 20 technology owners are based in Asia.
- 
- Solar PV differs from the other focus CCMTs in that all of the top 20 technology owners are based in Asia.
- 
- Patent activity in each of the focus CCMTs concerns a wide range of technologies at different stages of development or maturity.
-



- Patented innovations in the focus CCMT areas predominantly arises within the OECD & China, India is also a strong player
- There is huge diversity across sectors, players and technologies; coupled with relatively large amounts of ‘cross-over’ between technologies and sectors
- Patent ownership is concentrated with incumbents in established spaces (such as CCS, Super Critical Coal) and is more dispersed in emerging spaces (such as Wind)
- Enormous opportunities exist for developed **and** developing countries to develop world leadership in emerging spaces
  - E.g. PetroBas in Brazil
- Time taken to mass deployment of leading edge technologies is a concern: Our research shows that it takes between 19 to 30 years for top cited low carbon technologies to reach the mass adoption phase



The entire team, especially Sarah Helm, Ben Pellegrini and Harry Miller



WIPO staff including Anja von der Ropp, Anatole Krattiger, and many others



Bernice Lee and Felix Preston

- Read the Chatham House / CambridgeIP report: Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies

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CambridgeIP provides its clients around the world access to actionable research, insights, information, analysis and training. We assist our clients develop well informed policies, make fact-based investment decisions, accelerate the development and deployment of their valuable technologies and monitor their competitors. Our clients include government and international agencies, multinational corporations, research institutes and VC backed SMEs.

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See trends and insights in your industry, understand relationships between key stakeholders and emerging players, identify who owns key technologies

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- Understand
- The
- Whole
- Landscape

## Develop

Inform your developments

Find design ideas, integrate new technologies, secure relevant partnerships and licenses, understand core components of technology systems.

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## Monitor

Monitor IP & technology innovation

Track competitors and partners activities, monitor technology development and research trends, alerts about new players and new technologies

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Activity of key players in your space

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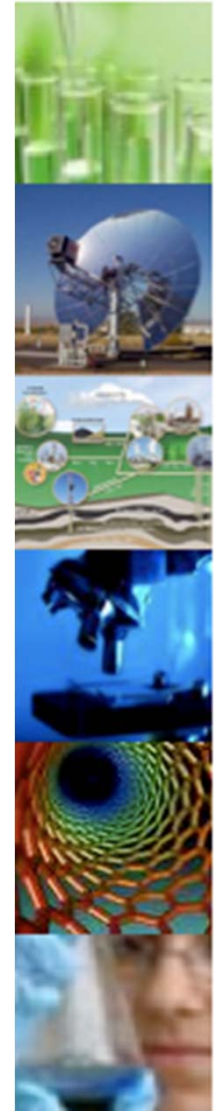
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<http://www.discoverip.cambridgeip.com/>  
Blog: [www.cambridgeip.com/blog](http://www.cambridgeip.com/blog)

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## Appendix

- Solar PV IP Landscape® case study
- CambridgeIP
- Contact us



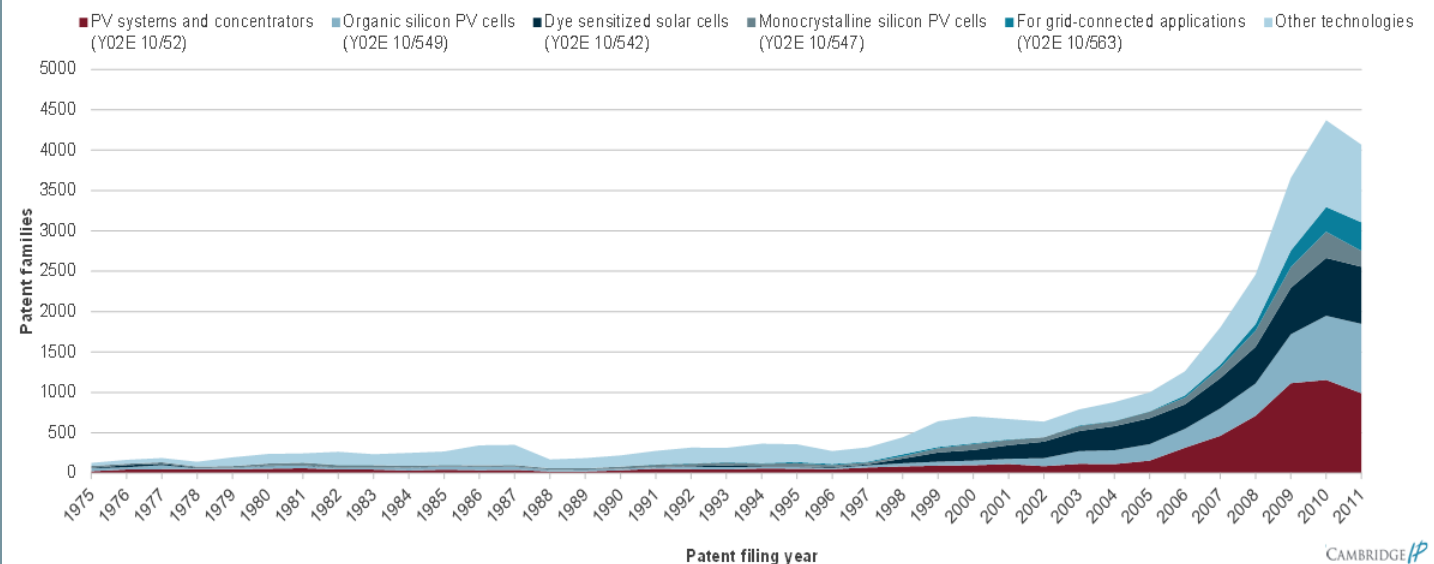
## CambridgeIP Insight

- Solar PV has the highest volume of patent filings of the four CCTMs presented in this report

- Solar PV also sees the highest annual average increase in patenting filings rate of 33%. The period with the highest rate of increase was from 2008 – 2009 in which patent filing rates increase by nearly 50%.

- Materials innovation accounts for 58% of innovation in the solar PV technology landscape for the period of 2006 – 2011, the most patent intensive materials focus was in organic silicon PV cells and dye sensitized solar cells.

Patent family filing trends for solar PV technologies:  
1975 - 2011



## CambridgeIP Insight

- Japanese companies play a prominent role in the solar PV patent landscape. Seven out of the top ten technology owners are Japanese based companies
- Large Corporate players in the Republic of Korea appear to be increasing their interests and investments in the solar PV, as evidenced by the ascent of LG and Samsung in the solar PV patent landscape
- Solar PV differs from the other focus CCMTs in that all top 20 of the top technology owners are based in Asia, and there is only one research institute among them, the other 95% are private entities

Table : Top 20 technology owners in solar PV

Rank			Technology Owners	Country of Company HQ	Patent Families 2006-2011
2006 - 2011	1975 - 2005				
1	20+	↑	LG	Republic of Korea	1108
2	4	↑	Mitsubishi	Japan	795
3	2	↓	Sharp KK	Japan	639
4	1	↓	Panasonic	Japan	633
5	16	↑	Samsung	Republic of Korea	572
6	5	↓	Kyocera Corp	Japan	357
7	20+	↑	Konica Minolta	Japan	271
8	11	↑	Fujifilm Corp	Japan	270
9	8	↓	Hitachi	Japan	268
10	20+	↑	Hyundai	Republic of Korea	207
11	10	↓	Sumitomo	Japan	206
12	12	→	Toyota	Japan	201
13	20+	↑	Industrial Technology Research Institute	China	199
14	15	↑	Sony Corp	Japan	195
15	20	↑	Dainippon Printing Co Ltd	Japan	187
16	6	↓	Fuji Electric Co Ltd	Japan	184
17	20+	↑	Toppan Printing Co Ltd	Japan	178
18	20+	↑	Trina Solar Co Ltd	China	174
19	20+	↑	Oceans King Lighting Science	China	161
20	7	↓	Kaneka Corp	Japan	149

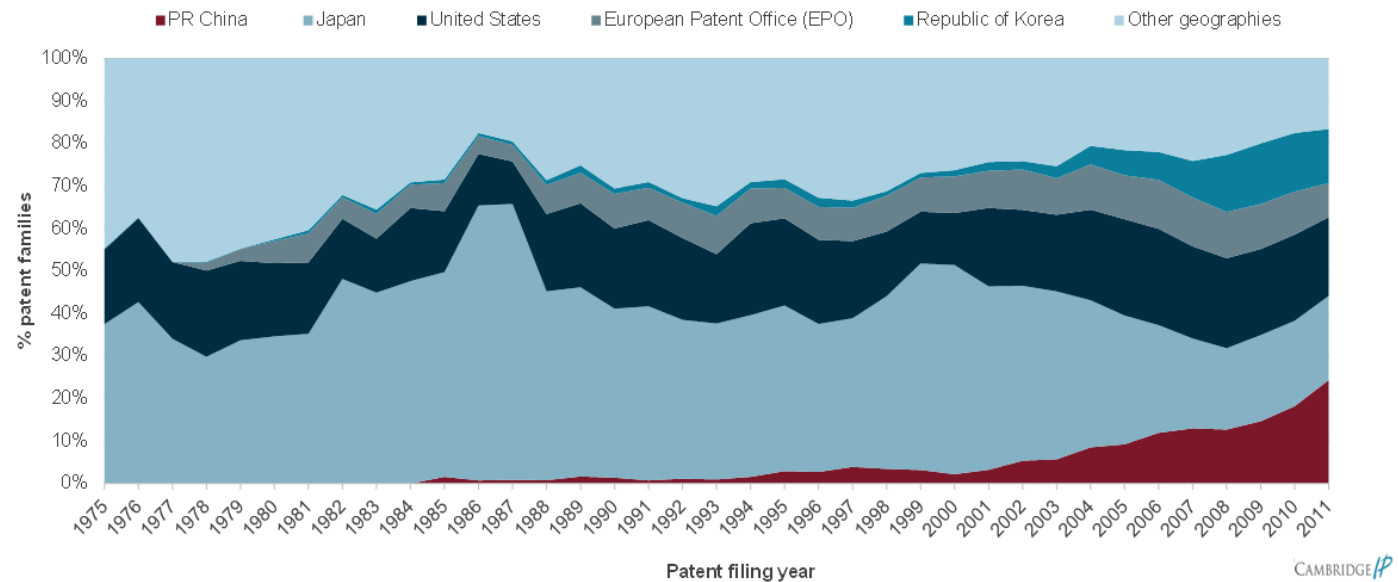


## CambridgeIP Insight

•In terms of patent filing locations there is a fairly even distribution between PR China, Japan and the United States, each accounting for approximately 20% in the period of 2006 – 2011

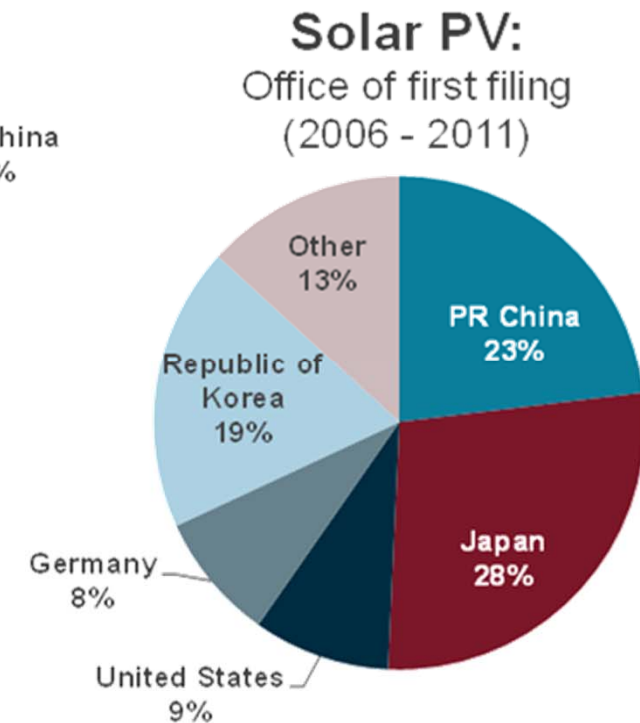
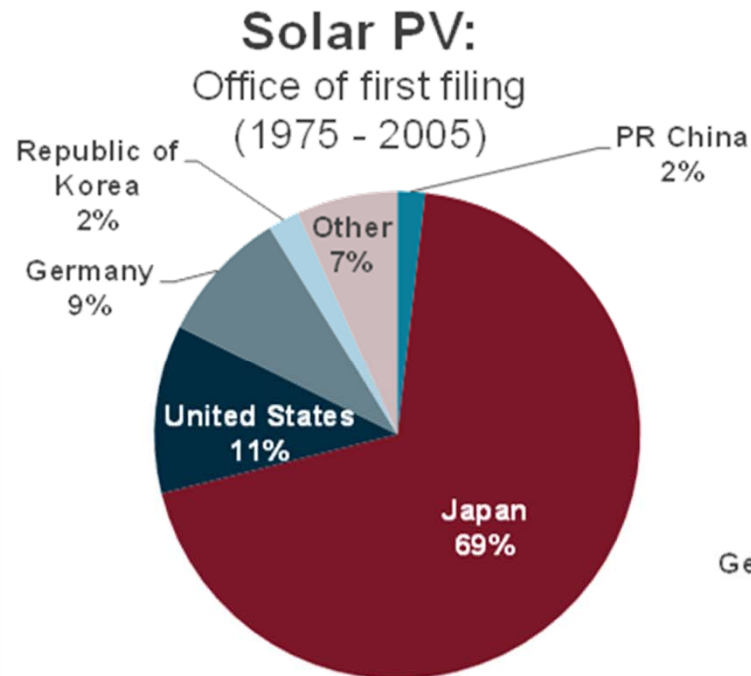
•Filings in the Republic of Korea account for 13% of all patent applications filed in the solar PV technology landscape in the 2006 – 2011 period; this accounts for at least 5% higher of a percentage of total filings than in any other CCMT technology space

Solar PV - proportion of patent families filed by patent authorities:  
1975 - 2011



## CambridgeIP Insight

- Japan is the most common office of first filing for solar PV; this is to be expected considering the prevalence of Japanese companies as top technology owners
- However, there has been a considerable drop in the dominance of Japan as an office of first filing, with PR China and the Republic of Korea accounting for much higher proportions
- See the case study of China emerging as more than a manufacturer for more detail on this patent first filing trend



# Top cited patents - Solar PV

## CambridgeIP Insight

- Top Cited patents in a technology field represent key technologies, that have led to further innovation .
- Many of these top ten cited patents are for manufacturing processes for Photovoltaic cells. Suggestive of maturing technology entering the manufacturing stage.

*NB Citation counts only available from US patents*

#	# Fwd citation	Publication number	Assignee	Title	Filing date	Publication date
1	176	US20080182358A1	Wilmington Trust, National Association (as agent for Eastman Kodak Company)	Process for atomic layer deposition	2007-01-26	2008-07-31
2	98	US7235736B1	Solyndra, Inc.	Monolithic integration of cylindrical solar cells	2006-03-18	2007-06-26
3	69	US20080092953A1	Stion Corporation	Method and structure for thin film photovoltaic materials using bulk semiconductor materials	2007-05-15	2008-04-24
4	66	US20080041446A1	Industrial Technology Research Institute [TW]	Dye-sensitized solar cells and method for fabricating same	2006-11-17	2008-02-21
5	65	US20080092945A1	Applied Quantum Technology LLC [US]	Semiconductor Grain and Oxide Layer for Photovoltaic Cells	2007-10-24	2008-04-24
6	57	US20090194165A1	Primestar Solar, Inc. [US]	Ultra-high current density cadmium telluride photovoltaic modules	2008-01-31	20090806
7	49	US7135350B1	Sunpower Corporation [US]	Use of doped silicon dioxide in the fabrication of solar cells	2006-01-09	20061114
8	49	US20060118163A1	Kineo Design Group, LLC	Rack assembly for mounting solar modules	2006-01-13	20060608
9	47	US20080210303A1	Guardian Industries Corp. [US]	Front electrode for use in photovoltaic device and method of making same	2008-02-01	20080904
10	46	US20070283997A1	Miasolé	Photovoltaic module with integrated current collection and interconnection	2006-06-13	20071213

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- Whole
- Landscape

## Develop

Inform your developments

Find design ideas, integrate new technologies, secure relevant partnerships and licenses, understand core components of technology systems.

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## Monitor

Monitor IP & technology innovation

Track competitors and partners activities, monitor technology development and research trends, alerts about new players and new technologies

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Activity of key players in your space

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