Rigorous empirical research on intellectual property

STUDENT CONTRIBUTION

Patents to climate rescue: how intellectual property rights are fundamental to the development of renewable energy

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Patents to Climate Rescue: How intellectual property rights are fundamental to the development of renewable energy.

Abstract

This is a brief overview of the role of patents in renewable energy technologies. It is designed to provide the reader with an introduction on the concept and importance of renewable energy production; the role patents are playing in the development of these technologies; a statistical snapshot of the patents trends and global output of renewable energy; various governmental policies; and case study highlights. With the latter showcasing how two successful companies have used their IP in this area from the perspective of a large company and an SME. This is the first introductory article which will delve into different aspects of the renewable technology sector and intellectual property.

Introduction

Climate change is the most pressing global challenge and with the international commitment to reduce greenhouse gas emissions under the Paris Agreement,[1] there needs to be a global energy revolution and transition.[2] This is where innovative technology can help meet the challenge of reducing our dependency on finite natural capital resources. The development and deployment of innovative technology play a pivotal role in enabling us to replace fossil fuel use with more sustainable energy solutions. Patents have facilitated the development of such innovative technologies thus far and will continue to be the catalyst for this transition.

Patents are among a group of intellectual property rights ('IPRs').[3] These are private and exclusive rights given for the protection of different types of intellectual creations. IPRs are the cornerstone of developed and knowledge-based economies, as they encourage innovation, drive the investment into new areas and allow for the successful commercialisation of intellectual creations. IPRs are the cornerstone of developed and knowledge-based economies.

Empirical evidence has shown that a strong IPRs system influences both the development and diffusion of technology. Alternatively, weak IPRs protection has been shown to reduce innovation, reduce investment and prevent firms from entering certain markets.[4]

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[1] The Paris agreement is an international environmental agreement adopted in 2015 and sought commitments from governments to keep global warming/temperature increase "*well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius*". Conference of the Parties, Adoption of the Paris Agreement, Dec. 12, 2015, U.N. Doc. CC/CP/2015/L.9/Rev/1 (Dec. 12, 2015).

[2] In addition to the Paris Agreement, global commitment to climate change appears as part of the the United Nations Sustainable Developmental Goals (SDG 13), which calls for all member states of the United Nations to enact urgent national polices and responses to alleviate climate change.

[3] Intellectual Property Rights consists of Copyright, Design Rights, Trademarks, Trade Secrets and Patents. See 4iP Council research which provides a dedicated and comprehensive resource in the 4SME's area for information on each type of intellectual property rights.

[4] Bernice Lee, Ilian Iliev and Felix Preston, 'Who Owns Our Low Carbon Future?: Intellectual Property And Energy Technologies: A Chatham House Report' (Royal Institute for International Affairs 2009) <https://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf> accessed 7 October 2020.

Once patent protection has been sought and granted, it gives a time-limited and exclusive rights to the creator of an invention. This allows the inventor or patentor the ability to restrict others from using, selling, or making the new invented product or process. Thereby allowing a time-limited monopoly on the exploitation of the invention in the geographical area where it is protected.

During the patent application procedure, the patentor must make sufficient public disclosure of the invention. This will allow others to see, understand and improve upon it, thereby spurring continuous innovation. Therefore, the patent system through providing this economic incentive is a successful tool which has encouraged the development and the dissemination of technology. Patents like all IPRs are key instruments in the global innovation ecosystem.[5]

When developing innovative technology, patents play a role throughout the "*technological life cycle*",[6] as shown in Figure 1.

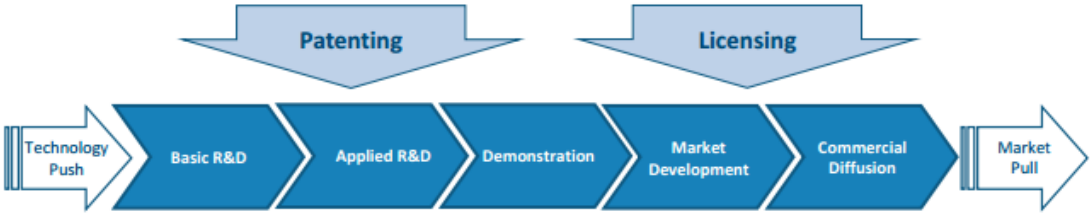

Figure 1: Patents facilitate advances throughout the technology life cycle (source: IRENA)

This lifecycle involves the invention, research and development ('R&D'), market development and commercial diffusion. Patents are most effective when sought at the R&D stage. Once a patent has been granted, it becomes an asset which can then be used to[7]:

- Gain Market Access: Patents can create market advantages; to develop and secure market position; to gain more freedom to operate within a sector and reduce risks of infringing on other patents; protect inventions from being copied, and removes delaying by innovative firms to release new or improved technology and encourage the expansion of their markets.
- Negotiation leverage: Patents can build a strong brand or company reputation which can enhance the company's negotiation power and allow for the creation of equal partnerships.
- Funding: Patents can generate funding and revenue streams for companies. Having a strong patent portfolio especially in small businesses or start-ups can be used to leverage investor funding; while also be a source of revenue for companies through licensing fees, sales, tax incentives, collateral for loans and access to grants and subsidies.

[5] See 4iP Council's 'Why should I care about intellectual property' infographic in the dedicated area for SMEs.
[6] Mirei Isaka, 'Intellectual Property Rights: The Role Of Patents In Renewable Energy Technology Innovation' (International Renewable Energy Agency [IRENA] 2013) <https://www.irena.org/publications/2013/Jun/Intellectual-Property-Rights-The-Role-of-Patents-in-Renewable-Energy-Technology-Innovation> accessed 7 October 2020.
[7] See 4iP Council's '4 Reasons to Patent' Infographic.

- Strategic value: Patents can be used to build "*synergistic partnerships*"[8] through which collaboration on R&D and other partnerships; be used to improve in-house R&D and build and/ or develop more products.

As such, obtaining and managing patent as part of a patent and broader IPRs strategy are key tools for business success, especially within highly innovative and technology-driven industries.[9]

Renewable Energy: The Basics

Renewable energy is derived from natural unlimited sources which produce little to no harmful greenhouse gases and other pollutants.[10] Innovative renewable energy technologies ('RETs') have created the ability to tap into these sources and convert them to energy which can then be stored, distributed, and consumed at a competitive cost. RETs have developed into a technology ecosystem which consists of alternative energy production, energy conservation and green transportation.[11]

For energy production, RETs have been developed to generate energy from six main sources. These are:

- Wind energy: Technology, via off-shore and/or on-shore wind turbines, harnesses the energy produced by the wind.
- Solar energy: Technology either through concentrated solar power ('CSP')and solar photovoltaic ('PV') harnesses the energy produced by the sun.
- Hydropower: Technology either through large-scale or small-scale hydropower plants, captures energy from flowing water.
- Bioenergy: Technology is used to convert organic material into energy either through burning to produce heat or power or through converting it to a liquid biofuel.
- Geothermal: Technology is used to capture the energy from the heat produced in the earth's core.
- Ocean/Tidal energy: Technology is used to capture the energy produced from waves, tides, salinity gradient energy and ocean thermal energy conversion.

Out of these six sources, the wind, solar and hydropower energy sectors are the biggest, the most developed and the most widely used. While geothermal and ocean energy sources are

[8] Isaka (n 5).
[9] European IP Helpdesk, 'Fact Sheet: IP In The Field Of Renewable Energies' (European IP Helpdesk 2019) <http://www.iprhelpdesk.eu/news/ip-field-renewable-energies> accessed 7 October 2020.
[10] Notably, within the renewable energy sector there remains issues of pollution. This can be highlighted with two of the biggest innovations; energy storage batteries and solar PV panels, these are among the hardest products to recycle/re-use leading to issues of waste. Fortunately, companies and governments are investing in the R&D to create innovative solutions to this issue. See Mitch Jacoby, 'It's Time To Recycle Lithium-Ion Batteries' (2019) 97 C&EN Global Enterprise <https://cen.acs.org/materials/energy-storage/time-serious-recycling-lithium/97/i28> accessed 17 October 2020.
[11] Kunihiko Fushimi and others, 'Measuring Innovation In Energy Technologies: Green Patents As Captured By WIPO's IPC Green Inventory' (World Intellectual Property Organization 2018) <https://www.wipo.int/publications/en/details.jsp?id=4351&plang=EN> accessed 7 October 2020

used in a more limited capacity. In particular, the RETs in ocean energy is still at its infancy and thus presents an opportunity for future innovation and commercialisation.

Renewable energy is the fastest-growing energy source, with the electricity sector showing the fastest energy transition. [12] In 2016, renewable energy accounted for 12% of final global energy consumption and in 2018, a milestone was reached with renewables being used to generate 26% of global electricity. The source of this energy has been driven by renewable hydropower, as shown in Figure 2, with wind and solar energy trailing behind in energy production. However, the International Energy Agency ('IRENA') forecasts that Solar PV will lead RETs to increase capacity in the upcoming years. [13]

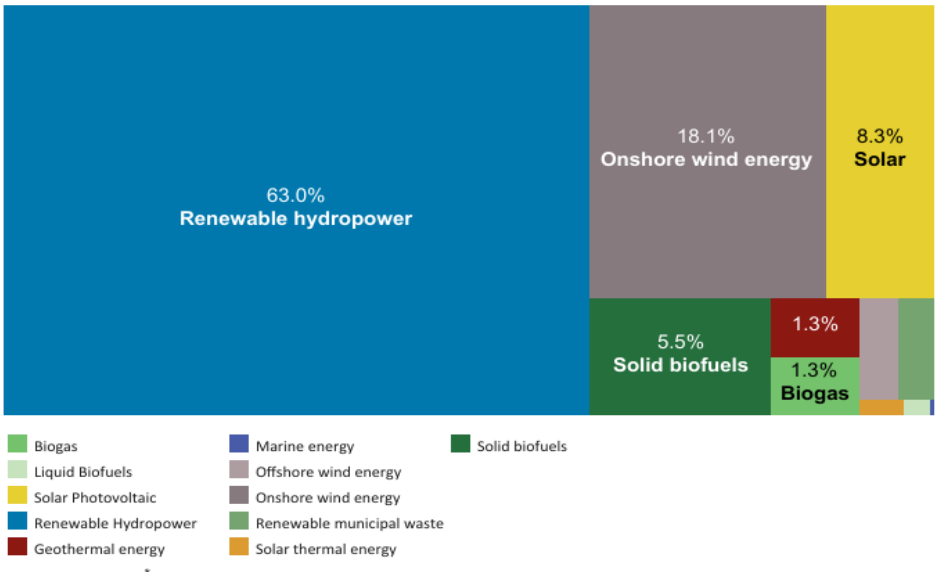

Figure 2: Renewable Energy Technologies (Source: IRENA)

This rise in renewable energy is due to the increased investment into the sector and the development, diffusion and deployment of innovative RETs.

For the period between 2010 and 2019, there were 2.6 trillion US dollars invested in renewable energy. [14] The majority of which being focused on solar energy.[15] This investment has surpassed the investment made into the traditional fossil fuel energy [16] and has been heavily driven by the private sector.[17] The International Energy Agency recent report showed that its

[12] IEA (2019), Global Energy & CO2 Status Report 2019, IEA, Paris. <https://www.iea.org/reports/global-energy-co2-status-report-2019>
[13] The International Renewable Energy Agency provides updated statistics and a comprehensive resources for the better understanding of RETs.
[14] United Nations Environment Programme; Frankfurt School of Finance and Management; BloombergNEF, 'Global Trends In Renewable Energy Investment 2020' (2020) <https://www.fs-unep-centre.org/wp-content/uploads/2020/06/GTR_2020.pdf> accessed 7 October 2020.
[15] Ibid
[16] Ibid
[17] The World Energy Council, 'Energy Sector Environmental Innovation: Understanding The Roles Of Technology Diffusion, Intellectual Property Rights, And Sound Environmental Policy For Climate Change' (The World Energy Council 2011) <https://www.worldenergy.org/publications/entry/wec-rules-of-trade-2011-energy-sector-environmental-innovation> accessed 7 October 2020.

members increased the public budgets for energy technology R&D, with the biggest increase in the low-carbon sectors.[18]

The geographic sources of this investment shown in Figure 3, reveals that the European Union, the United States and Japan are part of the largest investors. This reflects the historic involvement these countries have had in the renewable energy arena and the development of RETs. However, there is now the emergence of China, India and Brazil as large investors in this field.

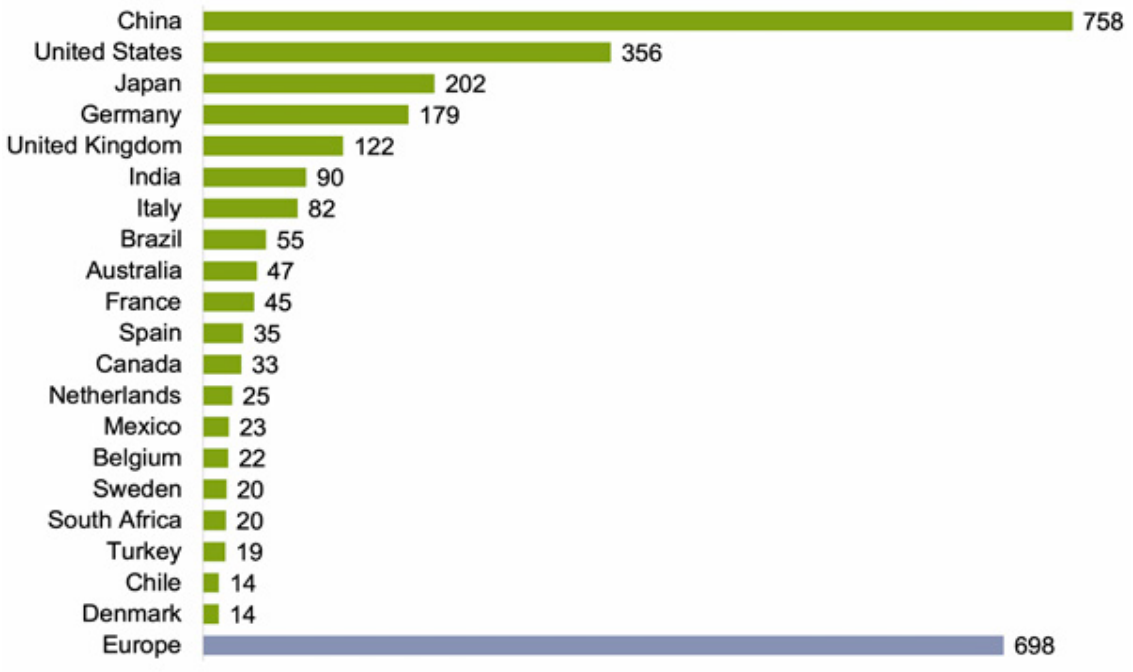

Figure 3: Renewable energy capacity investment from 2010 to 1h 2019, top 20 countries, $bn. Includes first-half data for 2019, but not an estimate for the second half, (source UN Environment, Frankfurt School-UNEP Centre, BloombergNEF)

This trend in investment has also coincided with the increase in patenting technology in renewable energy compared to fossil fuels.[19] Reports from the World Intellectual Property Office (WIPO), have shown that there has been a steady increase in patent filing rates in RETs since the mid-1990s.[20] This increase has occurred in the four major renewable sectors,[21] where RETs patents applications were growing steadily from 2005 until reaching a peak in 2013.[22] Post-2013, there has been a slight decline in patent filings, which can indicate a maturing of sectors and deployment of technologies.[23] Each renewable energy sector is at a different stage of maturity and thus there is a variation of patent ownership. The wind sector is the most mature

[18] IEA, 'Energy Technology RD&D Budgets 2020', IEA (2020), Paris https://www.iea.org/reports/energy-technology-rdd-budgets-2020
[19] Frankfurt School-UNEP Centre/BNEF (n 10).
[20] WIPO, 'The Acceleration Of Climate Change And Mitigation Technologies: Intellectual Property Trends In The Renewable Energy Landscape' (World Intellectual Property Organization 2014); WIPO, 'Renewable Energy Technology: Evolution And Policy Implications - Evidence From Patent Literature' (World Intellectual Property Organization 2014).
[21] Ibid; these are Biofuel, Solar Thermal, Solar PV and Wind.
[22] Ibid.
[23] Ibid.

and consequently has the highest intellectual property ownership and patent grants compared to that of the biofuel sector.[24]

IRENA also provides a comprehensive and interactive database for RETs patents. As seen in Figure 4 below, they have collected patent data from the major patent filing jurisdiction[25] which shows the breakdown of the patents per type. This information reveals that there is a dominance of patent filings focused on solar technology. This data corresponds to the focus of the investment in renewable energy into solar energy.

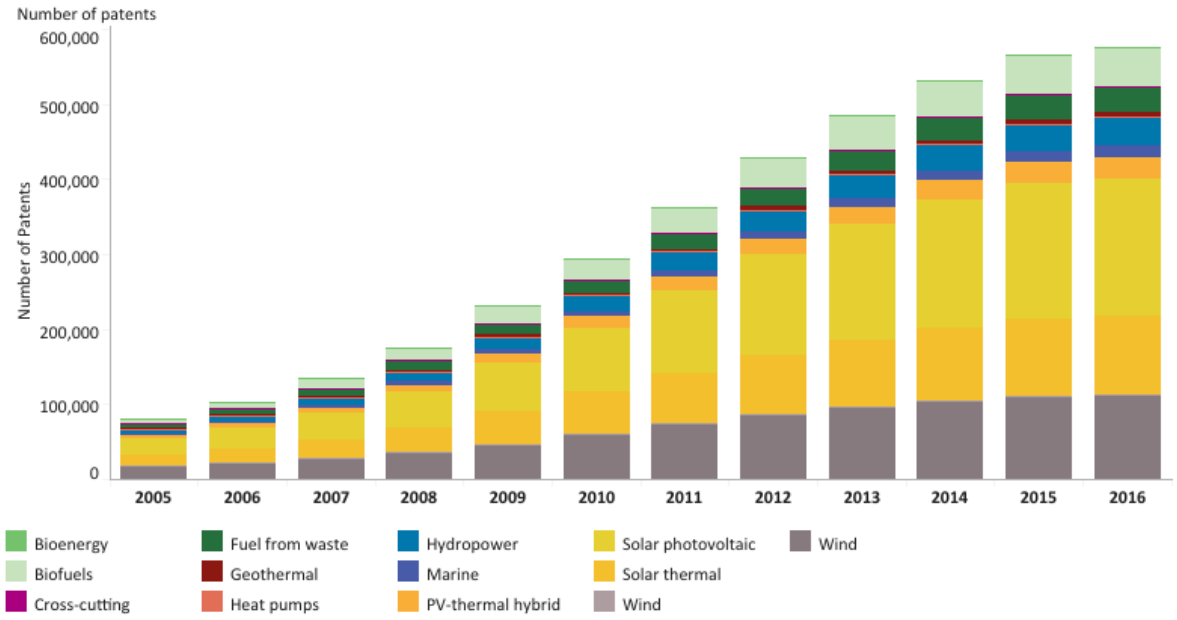

Figure 4: Renewable Energy Patent Evolution (source: IRENA Inspire, based on data from EPO PATSAT and also uses the Climate Change Mitigation Technologies (YO2) classification by EPO).

Upon closer look at the data, the geographic source of these patents shows that RETs patents have been concentrated in a few developed OECD countries and China. This also corresponds to the source of investment shown in Figure 3 and reflects the historical concentration of RETs innovation within these countries.[26]

The latest WIPO report for 2019, which looks at the data for PCT patent applications, shows that 76 % of all PCT patent application came from the United States, Germany, Japan, the Republic of Korea and China.[27] China is the newest entry into the top ten list and has made one of the largest jumps to become one of the biggest RETs patent filers at the PCT.

This geographic data is also mirrored by IRENA's statistics, as shown in Figure 5 below. This data also reflects China's emerging renewable dominance. China is heavily investing in solar

[24] Ibid.
[25] These are the PCT (WIPO Administered Patent Cooperation Treaty), USPTO (United States Patent and Trade Office, and the EPO (European Patent Office).
[26] David Criekemans, 'Geopolitics Of The Renewable Energy Game And Its Potential Impact Upon Global Power Relations', The Geopolitics of Renewables (Springer International Publishing AG 2020); and Lee (n 3).
[27] James Nurton, 'Patenting Trends In Renewable Energy' [2020] WIPO Magazine <https://www.wipo.int/wipo_magazine/en/2020/01/article_0008.html> accessed 7 October 2020.

energy technology and has filed numerous patents in this area and the underlying technologies.[28]

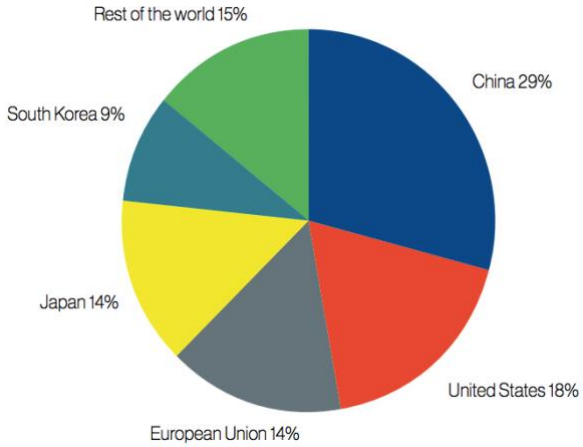

Figure 5: Cumulative share of renewable energy patents end in 2016 (source: IRENA)

The successful flow of investment in this sector can only occur in the presence of a strong IPRs system and protection. Government policies and initiatives to improve the patent system can be used to promote the development of RETs and drive private capital and investment into this area.[29] This direct effect on RETs through policies was shown in the United States with the '*Green Tech Pilot Program*'.[30] This was a special accelerated patent application procedure developed by the United States Patent and Trademark Office for inventions falling under the green technology category. This program ran from 2009-2011 and led to a boost in RETs patent applications, with the office issuing 1062 RETs patents from the programme.

Other jurisdictions, such as the European Union and China have used policy and incentives to promote the development of RETs and the advancement of their renewable energy sector. In particular, the European Union and China began the renewable energy path at different starting points but are now both dominant players in this area.

Profile the European Union: The Renewable Trailblazer

For the past three decades, the European Union has been at the forefront of the development and use of renewable energy and is now the leading innovation hub for RETs. This rise to prominence results from continuous ambitious regional[31] policies and incentives which sought

[28] Dominic Chiu, 'The East Is Green: China's Global Leadership In Renewable Energy' (2017) Summer 2017 New Perspectives in Foreign Policy
[29] Patrick Gattari, 'The Role Of Patent Law In Incentivizing Green Technology' (2013) 11 Northwestern Journal of Technology and Intellectual Property.
[30] Ibid.
[31] See for example the Renewable Energy Directive (2009/28/EC), which has been revised in 2018 to the amended to the Renewable Energy Directive (2018/2001/EU) and the Regulation on the Governance of the Energy Union and Climate Action (EU) 2018/1999.

to commit to adhering to climate change[32] and sustainable energy transition goals[33] coupled with a strong IPRs system.

During this period, the European Union set rolling targets for renewable energy.[34] This led to an increase in patents in the wind and solar and the placing of European companies as global leaders in the development of RETs.[35] This success has produced the following results:

- Europe is one of the largest sources of foreign direct investments in renewable energy.[36]
- One out of five low carbon inventions originates from Europe. [37]
- Two-fifths of "high-value patents", i.e. patents with the most economic potential and thus patented in multiple jurisdictions, are European. [38]
- The EPO is one of the most sought-after patenting offices and patents filed at the EPO produce the largest source of developed technology.
- Six of the top 25 Global leaders of renewable energy companies are Europeans.[39] This has allowed companies such as Vestas and Siemens Gamesa RE to become global market players and the most innovative companies in the wind energy sector.

Consequently, strong policies both at the regional level and amongst individual countries, as well as maintaining innovation in RETs, have resulted in European Union meeting its ambitious environmental and climate goals. The region renewable energy consumption rose from 9% in 2010 to 16% in 2015 and that the region can meet its 20% target in 2020.[40] This success has been achieved by not only encouraging innovation but also making RETs more accessible and affordable which allows the successful commercialisation and adoption of these technologies.

Profile China: The New Frontier for Renewable Energy

In the past decade, China has emerged as a new global player in renewable energy. They have embarked upon an ambitious energy transition goals in adherence to its climate change

[32] European Commission, 'Committing To Climate-Neutrality By 2050: Commission Proposes European Climate Law And Consults On The European Climate Pact' (2020) Brussels; which outlines the European Commision pledge to become carbon neutral by 2050 and will give support for individual states to meet these commitments.

[33] European Union Department of Energy. '*In Focus Renewable Energy in Europe*', (2020) Brussels: which outlines The European Green Deal, which sets out the overall action plan for the continent to become sustainable while also integrating the digitalisation of the EU energy market. This plan will transform the totality of Europe's energy value chain (i.e. energy generation, distribution, storage and consumption).

[34] European Commission, 'Energy Roadmap 2050' (Publications Office of the European Union 2012).

[35] The United Nations Environment Programme (UNEP), the European Patent Office (EPO) and the International Centre for Trade and Sustainable Development (ICTSD, 'Patents And Clean Energy: Bridging The Gap Between Evidence And Policy' (UNEP, EPO, ICTSD 2010).

[36] Frankfurt School-UNEP Centre/BNEF (n 10).

[37] The United Nations Environment Programme (UNEP) and the European Patent Office (EPO), 'Climate Change Mitigation Technologies In Europe – Evidence From Patent And Economic Data' (UNEP and EPO 2015) <https://www.epo.org/news-events/in-focus/sustainable-technologies/clean-energy/europe.html> accessed 7 October 2020.

[38] Ibid.

[39] Thomson Reuters, 'Top 100 Global Energy Leaders' (Thomson Reuters 2020).

[40] European Commission, 'Renewables: Europe On Track To Reach Its 20% Target By 2020' (European Commission 2017).

commitments, energy security and global leadership objectives. [41] This emergence as the new renewable energy '*superpower*'[42] is due to the fact that they are:

- The largest market for renewable energy.
- The leading producer of wind and solar energy. In 2017 China produced over 25% of the world's wind energy and increased its share of Solar PV energy.[43]
- The largest manufacturer of certain key components in RETs and 5 of the 6 largest solar-module and wind turbine manufacturers were Chinese companies in 2017.[44]
- As of 2019, they are the largest investor of renewable energy amounting to USD 83.4 billion or 23% of the global investment.[45]
- The largest patentor of RETs during the period of 2017-2019 and holding a cumulative 29% of global patents in 2016.

China's policies have focused on technological innovation and R&D and have recognised that this is central to the energy transition.[46] The WIPO PCT patent data shows that China holds the largest holder of patent families, which indicates that Chinese companies are patenting across more jurisdictions and these inventions have more commercial viability.[47] Notably, RETs are among the list of product and technology Chinese companies are incentivised to import into China.[48] This is part of the governments plan to acquire RETs and presents a valuable opportunity for foreign firms to form strategic partnerships to enter one of the largest and commercially active markets.

China rise also indicates the general global shift towards renewables. In the past years, the cost of key RETs has fallen allowing for easier access and the demand for electricity produced by RETs in the developing world.[49] In some cases, large scale wind and solar projects have replaced the traditional fossils fuel energy projects in some African and South Asian states.[50] Thus signalling a new market for these RETs and indication the necessary geographic diffusion to meet the global climate change targets.

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[41] At the 75th Session of the UN General Assembly, the Chinese President announced a new goal for China to be carbon neutral by 2060. This ambitious project will be a tripling of the commitment made under the Paris Agreement whereby China committed to attaining 30% of its energy from renewable energy sources.
[42] Global Commission on the Geopolitics of Energy Transformation, 'A New World: The Geopolitics Of The Energy Transformation' (Global Commission on the Geopolitics of Energy Transformation 2019) <http://www.geopoliticsofrenewables.org/> accessed 7 October 2020.
[43] China Power Team, 'How Is China's Energy Footprint Changing?' China Power. (February 15, 2016. Updated August 26, 2020) < https://chinapower.csis.org/energy-footprint/.> accessed October 7, 2020.
[44] Michael Slezak, 'China cementing global dominance of renewable energy and technology,' *The Guardian*, January 6, 2017, <https://www.theguardian.com/ environment/2017/jan/06/china-cementing-global-dominance-of-renewable-energy-and-technology >accessed October 1,2020.
[45] Frankfurt School-UNEP Centre/BNEF (n 10).
[46] See the White Paper of China's Energy Policy in 2012, which outlined the country's sustainable energy goals and strategies. It emphasized on scientific and technological innovation and expansion of international cooperation in the field of renewable energy.
[47] Nurton (n 22).
[48] Chiu (n 23); and David Solomon, 'Chinese Companies Encouraged To Purchase Foreign Products - China Business Review' (*China Business Review*, 2020) <https://www.chinabusinessreview.com/chinese-companies-encouraged-to-purchase-foreign-products/> accessed 7 October 2020.
[49] European IP Helpdesk, 'Fact Sheet: IP In The Field Of Renewable Energies' (European IP Helpdesk 2019) <http://www.iprhelpdesk.eu/news/ip-field-renewable-energies> accessed 7 October 2020.
[50] EY, 'Recai - Renewable Energy Country Attractiveness Index' (EY 2016).

Whilst some critics have suggested that the patent system dominated by developed countries can lead to unequal access or no access to RETs by the developing countries. The empirical evidence has shown that a strong IPRs system along with environmental policies have ensured that there is an appropriate technology transfer.[51] This reflects the general research which shows as a whole the patent system does not impede on the *"economic development and local innovation in developing and emerging-market countries*".[52] This effective diffusion of RETs is necessary for the global response needed.

Governmental policies which support IPRs can have a direct impact on the advancement of RETs. Therefore, governments should continue to support IPRs friendly policies as this will result in the necessary R&D and technology transfer by providing a return on investments and the legal support and protection necessary for continued private sector investment.[53] Further, a strong IPRs system allows for faster technology development through partnerships. It will also allow private firms to invest in R&D in the developing world and find innovative local solutions to the country or region-specific challenges.[54] Thus encouraging a more distributed private sector investment and the development of indigenous domestic innovation ecosystem.

The importance of Governmental policies which support environmental and climate change goals cannot be understated. This support can take the shape of strong environmental policy and laws which penalises and discourages investment in fossil fuels as well as increases regulation on these industries and/or providing positive incentives in RETs innovation through the use of grants, loans, tax incentives or subsidies. This will create the economic and social environment necessary for the advancement of RETs investment, innovation and transfer. Denmark stands as a testament of successful environmentally-friendly industrial policy, which they have embarked upon since the 1970s. This has led them to be a world leader in the use of renewable energy and fostering pioneering and dominant companies, as seen in the case study of Vestas Wind System A/S, in the field of wind energy. Thus, merging energy security and economic growth.

Conclusion

It must be highlighted that this transition to renewable energy will profoundly affect the global geopolitical system.[55] As each country and region pursue their own renewable energy goals; due in part as a commitment to fighting climate change but also in part as a means of securing energy independence and economic development.

Consequently, there is a race to create new technologies in this area. Thus, it is imperative for all countries to accelerate the adoption and creation of RETs. As evidenced, patents are

[51] Valentina Bosetti and Elana Verdolini, 'Clean and Dirty International Technology Diffusion' (June 3, 2013). FEEM Working Paper No. 43.2913, Available at SSRN: https://ssrn.com/abstract=2273458 or http://dx.doi.org/10.2139/ssrn.2273458.
[52] Jonathan M. Barnett, 'Patent Tigers and Global Innovation', (Winter 2019-2020) Regulation 14-18. A summary of paper available on 4iP Council.
[53] The International Chamber of Commerce (ICC), 'ICC Submission On The Review And Assessment Of The Effectiveness On The Implementation Of Article 4, Paragraph 1(C) And 5, Of The Convention.' (UNFCCC 2009).
[54] World Energy Council (n 13).
[55] Global Commission (n 36).

essential to this drive. The IPRs have been crucial to the technological revolution affecting all aspects of life and will continue to be a major catalyst for this energy transition.

The development of innovative RETs for providing sustainable energy production is one part of the equation for sustainability and meeting climate change goals. These technologies must be developed and deployed along with innovative technologies for energy efficiency, energy storage, carbon capture and carbon storage.[56] Moreover, the renewable energy sector is also undergoing digitalisation and there is a need for innovative companies to create sensors, software, artificial intelligence, platforms etc. Thus, there is a need for wide-ranging innovation and this is a space where innovative energy technology start-ups can co-exist with the large companies in the renewable energy ecosystem. Markedly, there is also a space for cutting edge innovation to treat with the side-effects of traditional energy sources, where start-ups, research institutions and universities can explore.[57]

Recognising this need, in 2019 there was a boom of private investment flowing to energy technology start-ups.[58] This investment came from both venture capitalists and corporate investors which comprised of traditional fossil fuel companies, renewable energy companies and companies in the transport and ICT sectors.[59] With the corporate investors either acquiring the start-ups to gain capacity and integrate the technology into their products or just gaining a share of these innovative companies.[60] This provides a whole sector for SMEs to develop innovative technology protected by patents in these areas. The appropriate government policies and funding can incentivise the necessary exploration by start-ups and research institutes to undertake the necessary R&D in this area. Once firms have successfully created a RETs, employing a smart IPRs strategy and management system can ensure commercial success. This is seen in the case study highlight of the innovative SME Orcan Energy AG.[61]

Whilst progress has been made thus far in combatting climate change, a recent United Nations report revealed that the world is not proceeding at the necessary pace to meet the targets.[62] As each country is lagging in their national commitments. Thus, there is an urgent need to innovate

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[56] Sebastian Lohse, 'Incentivizing The Adoption Of Green Technology On A Global Scale' (World Intellectual Property Organization 2014) <https://www.wipo.int/publications/en/details.jsp?id=3912&plang=EN> accessed 7 October 2020.

[57] See feature interview on 4iP Council with Alex Smith, Intellectual Property Manager at the Sellafield site, which manages the waste of this former Nuclear Energy Plant and is part of the UK's Nuclear Decommissioning Authority (NDA). This interview discussed the role on patents and innovation in this fie;d.

[58] Simon Bennet, 'Non-Traditional Energy Companies Lead A Record Year For Corporate Investment In Energy Start-Ups' (IEA 2019) <https://www.iea.org/commentaries/non-traditional-energy-companies-lead-a-record-year-for-corporate-investment-in-energy-start-ups> accessed 21 October 2020.

[59] Ibid

[60] Ibid

[61] Christian Hackl and Thomas Bereuter, 'From A Spin-Out To International Player: A Case Study', *Winning with IP: Managing Intellectual Property Today* (Novaro Publishing 2019); and Christian Hackl, 'Recycling Waste Heat To Cool Down The Planet' (European Patent Office 2017) <https://www.epo.org/learning/materials/sme/sme-case-studies.html> accessed 7 October 2020.

[62] 'World Off Track In Meeting 2030 Agenda, UN Deputy Chief Warns, Calls For Solidarity In COVID-19 Recovery' (*UN News*, 2020) <https://news.un.org/en/story/2020/07/1068551> accessed 17 October 2020.

and deploy the necessary technologies which can face the challenge and avoid the negative economic and social consequences of climate change.

Case Study SME: Orcan Energy AG[63]

Orcan Energy AG is a renewable energy SME founded in 2008 as a "spin-off"[64] from the Technical University of Munich (TUM) in Germany. Through the development of innovative technology, they specialise in the conversion of waste energy from the industrial, marine, and power generation sectors into clean electricity. The early technology was developed by researchers at TUM, who then left to form ORCAN. Recognising the value of a strong IPRs policy and the necessity for a strong patent portfolio for their success, the founders entered negotiations with TUM to become the sole owners of these early patents.

This ownership allowed them to attract the necessary start-up investment, provide a secure asset for investors, reduce the cost for negotiating licensing rights and usage, highlight their innovativeness, create a solid reputation and build beneficial partnerships with other manufacturers. They have continued to invest in R&D and securing their innovation through a calculated patenting and IPRs strategy, especially as their technology can be reversed engineered. This strategy has allowed them to gain a large and valuable patent portfolio consisting of 180 patent applications across the PTC and EPO system and 27 patent families. Their patent scope is one based on a cost-benefit analysis, thereby the key technology is patented in a wider geographic area as opposed to narrow specific components which are more selectively patented.

Orcan's first commercialised their products within the European Union (Germany, France, United Kingdom, and Italy). They have now expanded their reach internationally by entering the markets within the United States, Japan, and China. With the latter, Orcan saw the potential for growth in the Asian market, and as a small European company, it needed a knowledgeable and connected partner to enable a successful entry. Thus, after careful vetting, Orcan entered a joint venture with a Chinese company, where they granted an exclusive license for production, sales and operation within the China and other Asian and African countries. For this venture to be successful, Orcan produces its core/valuable components in Germany and then ships it to the Chinese partners, who complete the final product. The completion is done with the oversight of Orcan who tests and ensures quality control. This hybrid partnership mitigates certain risks in entering new, and unfamiliar markets while ensuring both parties benefit.

[63] Hackl and Bereuter; and Hackl (n 61).
[64] Ibid.

Case Study of the Wind Pioneer: Vestas Wind Systems A/S

Wind energy is one of the first forms of renewable energy, it is one of the most established and mature sectors and '*one of the fastest-growing renewable energy technologies'*.[65] Wind energy currently provides the second-largest source of electricity derived from renewables.[66] This sector consists of wind turbines used on-shore which has been the most popular and the emerging offshore wind energy market. The latter is expected to grow rapidly due to recent technological advancements which create new opportunities for countries to explore this resource. The largest markets for wind energy are the United States, Europe, India and China. With the latter two emerging in recent years and Chinese companies have become large players in this area. New markets are appearing in the regions of the Americas, Asia-Pacific, and Africa, as the cost for this RET has reduced and become more accessible. This market has become highly competitive and dominated by four main companies[67], who invest in intellectual property to secure their positions and engage in the assertion of patents rights through patent litigation.[68]

Vestas Wind Systems A/S ('Vestas'), is one of the leading global companies in renewable energy. This Danish company specialises in developing, manufacturing, installing, and servicing wind turbines in both the on-shore and off-shore wind sectors. Vestas has been leading the wind energy sector for the past forty years and has maintained its position as the world's largest producer of wind turbines. They have a global presence in eighty countries and as of 2018, they were the leading company in most major markets.[69]

In 2019, Vestas continued to have the largest global market share in the wind energy sector, with 18% [70] and they recorded more than 12 billion euros in revenue.[71] This feat is due to Vestas focus on continuous innovation and their investments into R&D which has ensured their technological leadership in this sector. Vestas' success is the result of placing importance on its IPRs, viewing them as valuable assets which strengthen their market position. Thus, they secure their investment in R&D with intellectual property by fully utilising the patent system. They continuously file a large number of patents across different key jurisdictions, which not only includes their main markets but also potential markets. Patents are sought not just for innovative incremental improvements and new designs of the wind turbines themselves but

[65] IRENA, "Wind" (*IRENA International Renewable Energy Agency*) <https://www.irena.org/wind> accessed October 15, 2020

[66] IEA (2020), *Onshore Wind*, IEA, Paris https://www.iea.org/reports/onshore-wind

[67] The top four companies in this sector have 55% of the market share in this sector and they are: Vestas (Denmark), Siemens Gamesa (Spain), Goldwind (China), and GE (United States).

[68] Wenlong Qian, 'Wind Power & IP' (ClearView IP 2013) <https://www.clearviewip.com/reports/wind-power-ip/> accessed 19 October 2020.

[69] IRENA, 'Future Of Wind: Deployment, Investment, Technology, Grid Integration And Socio-Economic Aspects - A Global Energy Transformation Paper', (International Renewable Energy Agency 2019).

[70] Veronika Henze, 'Vestas Still Rules Turbine Market, But Challengers Are Closing In | Bloombergnef' (*BloombergNEF*, 2020) <https://about.bnef.com/blog/vestas-still-rules-turbine-market-but-challengers-are-closing-in/> accessed 20 October 2020..

[71] Vestas Wind Systems A/S, 'Annual Report 2019' (Vestas Wind Systems A/S 2020).

also for the surrounding technologies, processes and methods[72], installation and assembly of the turbines, energy storage and efficiency and monitoring of wind farms.[73]

As such Vestas has engaged in the continuous acquisitions of companies whose R&D are valuable and necessary to the strategic improvement of products.[74] According to a WIPO report, Vestas is ranked as the fourth global technology owner in the wind energy sector and have reported ownership of 237 patent families during the period 2006-2011.[75] Further, they engage in strategic global enforcement of patent rights.

In addition to the use of patent protection, Vestas IP strategy uses trademarks to strengthen their brand value and they have a comprehensive system and policy using trade secrets as a means of protecting their technology and operations. Vestas underlying aims of their IP strategy are "*freedom to operate in existing and future markets and protection of the company's IP assets"*.[76] This strategy is implemented not only '*throughout the Vestas value chai*n', but also within Vestas' external partnerships and collaborations.[77]

Vestas was originally a manufacturer of farming machinery formed in Denmark in 1898.[78] During the 1970's Denmark suffered an energy crisis which caused the government to explore alternative sources of energy. Finding potential with wind energy, the government created an industrial policy to support this developing sector, through the provision of direct and indirect instruments.[79] These instruments included R&D incentives to the then group of small Danish manufacturers. Vestas being amongst this group was able to purchase the patent license from the famed Danish inventor, Henrik Stiesdal, for the revolutionary new design of the three-bladed rotor for wind turbines. This design has become the industry standard and known as the '*Danish Concept'*.[80] This strategic and valuable acquisition allowed Vestas to successfully produced its first commercial wind turbine in 1979 and established themselves within the local market and then continued to international expansion.[81]

These early days of the Danish industry were one of open innovation and knowledge sharing which resulted in low patenting rates.[82] However, as the industry matured this policy shifted to

[72] Such as patents for technology which can reduce heat and noise to ensure the wind turbines do not disrupt and disturb the surrounding environment.
[73] 'Patenting The Winds Of Innovation | Wind Systems Magazine' (Windsystemsmag.com, 2012) <https://www.windsystemsmag.com/patenting-the-winds-of-innovation/> accessed 15 October 2020.
[74] Ibid; and 'Vestas Acquires Technology Wind Power Assets From OCAS | REVE News Of The Wind Sector In Spain And In The World' (Evwind.es, 2011) <https://www.evwind.es/2011/10/08/vestas-acquires-technology-wind-power-assets-from-ocas/13988> accessed 21 October 2020.
[75] Sarah Helm, Quentin Tannock and Ilian Ilieve, 'Renewable Energy Technology: Evolution And Policy Implications— Evidence From Patent Literature' (World Intellectual Property Office 2014).
[76] Vestas Wind Systems A/S, 'Annual Report 2017' (Vestas Wind Systems A/S 2018).
[77] Ibid.
[78] 'Profile' (*Vestas.com*, 2020) <https://www.vestas.com/en/about/profile> accessed 18 October 2020.
[79] Enrico Botta, 'Green Growth: A Case Study On The Danish And Chinese Sectoral Innovation Systems' [2013] SSRN Electronic Journal.
[80] European Patent Office, 'Wind Energy Pioneer Henrik Stiesdal Named European Inventor Award 2018 Finalist' (2018) <https://www.epo.org/news-events/press/releases/archive/2018/20180424n.html> accessed 20 October 2020.
[81] After developing the first commercial wind turbine within Denmark in 1979, when the State of California in the 1980's embarked on a new policy and incentives to develop its wind sector, Vestas using its track record within Denmark, was able to leap forward in this new market, thus expanding the company. See Soren Krohn, 'Danish Wind Turbines: An Industrial Success Story' (*Ele.aut.ac.ir*, 2001) <http://ele.aut.ac.ir/~wind/en/articles/success.htm> accessed 20 October 2020.
[82] Botta (n 13)

one which embraced IPRs, thereby increasing patenting rates. This relaxed approach to patents was also mirrored within the global wind sector as a whole. However, in the early 2000s, due to increasing competition, the sector also began to dramatically increase its rate of patent applications.[83]

In 2005, under new leadership, Vestas underwent a radical transformation, where there was a reconceptualization of its corporate and its R&D strategy. They created a centralised global network of R&D centres located near important markets[84] while increasing the amount invested in this area.[85] Along with creating an innovation support network which includes strategic external collaboration with research institutions and universities, engaging in new ventures and acquisitions of technology and most importantly '*a strategic focus on intellectual property rights'*. [86] This focus on continuing technology development was a means to maintain their success.[87]

This restructuring helped secured Vestas current position and continued technological leadership. To continue its expansion and market access Vestas has now engaged in strategic partnerships and joint ventures, such as:

- In 2014 with Mitsubishi Heavy Industries (MHI) to form MHI Vestas Offshore Wind, whose focus is on the emerging offshore sector.
- In 2019 with Mercedes Benz EQ Formula E team to explore the electrification of the transport and motorsport sectors.[88]
- In 2017 with battery producer Northvolt AB through a strategic partnership.[89]

Vestas has also embarked in the digitalisation of their wind turbines, through the implementation of sensors to gather data and enhance its smart data analytics. As well as continuing to expand the hybridisation of renewable energies.

[83] Ibid.
[84] Ibid.
[85] Vesta Wind System A/S (n 71); Vestas has invested increasing amounts in R&D, with Euro 372 million spent in 2019, which was up from Euro 325 million in 2018.
[86] Torben Pedersen, 'Vestas Wind Systems A/S: Exploiting Global R&D Synergies' [2009] SMG Working Paper, No. 5/2009.
[87] Ibid.
[88] Vesta Wind System A/S (n 71)
[89] Ibid.