

# Innovation management in renewable energy sector

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**Abstract.** As a result of the globalization of knowledge, shortening of the innovation cycle and the aggravation of the price situation, the diffusion of innovation has accelerated. The protection of innovation has become even more important for companies in technology-intensive industries. Legal and actual patent right strategies complement one another, in order to amortize the investment in product development. Climate change is one of today's truly global challenges, affecting all aspects of socio-economic development in every region of the world. Technology development and its rapid diffusion are considered crucial for tackling the climate change challenge. At the global level, the last decades have seen a continuous expansion of inventive activity in renewable energy technologies. The growth in Renewable Energy (RE) inventions has been much faster than in other technologies, and RE today represents nearly 6% of global invention activity, up from 1.5% in 1990. This paper discusses about global innovation activity in the last five years in the renewable energy sector and describes the Innovation and Technology Management process for supporting managerial decision making.

## 1. Introduction

At the beginning of the 21st century, the business world is dynamic and complex and the competition is globalized. As a result of the globalization of knowledge, shortening of the innovation cycle and the aggravation of the price situation, the diffusion of innovation has accelerated. The global competition has increased to development new technologies and has forced the player to be international.

Innovation is now recognized by governments and corporations alike as a key driver of economic and business growth. Innovation is not only limited to the development of new products, but also includes the development of new services and business practices. Hence, an essential component of innovation management is to establish differentiation advantages with the customer, and find ways in which to make these advantages sustainable and renewable [1].

A cornerstone of innovation and technology management is the establishment of technology monitoring systems, which allow a company to timely anticipate technology changes within its competitive environment, which can, at the same time, yield either chances for new business opportunities or risks for existing businesses [2].

## 2. Inventive activity in energy and environmental technologies

Inventions and innovations determine considerably the efficiency and the success of the modern economy. Successful organizations, enterprises and universities protect their innovations with patent rights of the intellectual property, in particular with patents. The technology information makes searches to the conditions for the technology possible, after new products and procedures, potential co-operation partners and licensees. Beyond that patent data bases are suitable in addition, for



systematic/statistic patent analyses. So competition and market analyses can in certain product range/technology fields be e.g. accomplished and technological trends in time are identified. This is probably the most perfect technical data base, which contains with high probability the entire technical knowledge convertible into practical application of mankind, makes thus the rapid access possible to the patent documents relevant for a concrete technical question. Each question can be answered by recourse to of the comprehensive technical documentation of the patent office and the expert knowledge over already existing technical knowledge on each technical field of activity fast, comprehensively and reliably. The correct information at the correct time for the order to have is the key to success [3].

Clean energy is the most pressing challenge of our time, affecting all aspects of socio-economic development in every region of the world. The development a new low-carbon- emissions technologies and diffusion of technologies is the key to making such a transition possible. Innovation and new technology development and its rapid diffusion are considered crucial for tackling the clean energy challenge.

The 21st Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) represents a milestone in over 20 years of negotiations. The Parties aim to conclude an international legally binding agreement to replace the Kyoto Protocol of 1997, designed to limit greenhouse gas (GHG) emissions in all signatory states.

In December 2015, government leaders from around the globe gathered in Paris for the 21st session of the Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change (UNFCCC), with the objective of concluding a legally binding international agreement aimed at limiting the average global temperature increase to 2°C above preindustrial levels. The 2015 United Nations Climate Change Conference (COP 2) represents another milestone in clean energy politic.

The reductions in GHG emissions entailed by this goal pose a significant challenge. In this context, innovation and technology management play a key role in meeting these requirements. The current Climate Change negotiations recognize the need to strengthen this pillar by, among other things, the establishment of a technology mechanism to accelerate innovation and development clean energy technology [4].

### **3. The role of intellectual property rights (IPRs) in the development of new clean energy technologies**

New technology development and dissemination play a crucial role in tackling the clean energy challenge. The IPRs, such as patents, trade secrets, copyright, utility models, industrial designs and trade marks, play an important role in innovation management of clean energy technologies. In particular, patents are a mechanism to accelerate new technology development and especially their transfer in the practice.

As an innovation support system for new technology development, the patent system contributes to promote innovation and the diffusion of new technology. Moreover, it is an extremely powerful tool for measuring innovation potential and disseminating information, ultimately contributing to a more transparent and balanced knowledge economy.

In granting temporary exclusive rights in exchange for the disclosure of an invention, the patent system supports innovation by providing protection while an inventor or enterprise brings an invention to market. Patent applications for clean energy inventions are rich in information about the latest technical developments in this field. In addition, the patent system encourages R&D and allows further research to build upon existing technologies and supports innovation and technology transfer.

The deployment of new technologies is crucial to tackling clean energy. Whether it involves developing new breakthrough inventions or decarbonizing existing technologies, solutions are urgently needed to cut greenhouse gas emissions while meeting the world's growing energy demands. New technology development and dissemination is considered to play a crucial role in tackling the clean energy challenge.

In this context, the number of inventions in clean energy technologies worldwide has gone up steadily since the Kyoto Protocol was signed in 1997. This suggests that the implementation of clean energy policies has been essential for stimulating their development. The growth in low-carbon inventions has been much faster than in other technologies: they represent in 2011 nearly 6% of all inventions across the world, up from less than 2% before 1997.

As a result, rapid technological advances in green technologies have contributed to reducing Europe's carbon emission intensity by 30% in the past decades, and since 2000 it has remained the world's lowest. Public policies put in place after Kyoto appear to have been particularly successful in encouraging the development of CCMTs in Europe. [4].

The study from European Patent Office (EPO), and the United Nations Environment Programme (UNEP) study (2015) used patent and economic data on CCMTs in Europe. The EPO-UNEP study showed that Europe is now a global leader in CCMTs inventions, together with Japan, the US, Korea and China. European inventors were responsible for around 18% of CCMT inventions developed in the world during the period studied, despite the increasing competition from China and Korea. Europe is the world's biggest importer of CCMT goods; and in CCMT exports, is second only to China. Cross-border patent filings appear to go hand in hand with trade and foreign investment in CCMTs. [4].

According to statistical analysis from EPO, patenting rates (patent applications and granted patents) in the selected clean energy technologies (CETs) have increased at roughly 20 per cent per annum since 1997. In that period, patenting in CETs has outpaced the traditional energy sources of fossil fuels and nuclear energy. The surge of patenting activity in CETs coincided with the adoption of the Kyoto Protocol in 1997, which provides a strong signal that political decisions setting adequate frameworks are important for stimulating the development of CETs. The fields experiencing the most intensive growth include solar PV, wind, carbon capture, hydro/marine and biofuels [5].

The intellectual property rights, especially the international patent system facilitates development of new clean energy technologies by providing legal protection for inventions across multiple markets. It supports exports and foreign direct investment, and creates an efficient framework for technology transfer. Patent trends and statistics also provide powerful and important early indications of technological and economic developments. They are an excellent source of business decision, enabling trend analysis and monitoring of competitors.

IPRs are one of many factors influencing business' decisions to develop new clean energy technologies, or to invest in a particular country. Therefore, it becomes apparent that the effects of IPRs and their strengthening are often dependent on their interrelationship with other factors, such as the size of the domestic or foreign market, the structure of factor supply, infrastructure and the degree of stability of the economic environment.

Because the issue of clean energy has gained prominence in the political and public discourse, most companies are adapting their business strategies.

#### **4. Method**

Patent data were aggregated using Derwent World Patents Index (DWPI) database from STN International to identify global patenting activity in the fields of Renewable Energy (RE) technology and specifically in clean energy area. Patenting activity is being used as a benchmark for innovation. We selected areas identified as hotbeds of inventive activity over the last five years based on their observation of increased patent activity.

We analyzed the total number of unique inventions issued in published patent applications and granted patents from 2010 to 2015. The patents are published or granted in minimum two countries.

Both granted patents and published applications were included in the analysis in order to address the time delay between an invention being accepted as a valid application and the granting of the patent. The lag time between a patent application date and patent issuance can be as long as 4.5 years; by including both published applications and granted patents, we were able to get a more accurate

reading of true innovation within the select categories studied. Results were compared to determine the overall growth trend over the last five years.

## 5. Results

To find the hotbeds of inventive activity and tomorrow's big innovations, we have analyzed global patenting activity in RE technology fields that have shown significant growth over the past several years.

Medical technology, biotechnology and the Life Science domain are currently undergoing an enormous push toward development worldwide. In 2015 in Europe was Medical technology the field with the highest volume of European patent applications and was also one of the fastest growing areas (an increase of 11.0 % over 2014). Other fields with strong growth were Engines, pumps and turbines (+17.9%), Pharmaceuticals (+9.6%), Measurement (+8.0%) and Computer technology (+7.8%). Only Transport and Electrical machinery and energy showed a slowdown in the number of patent applications. This was 1.8% fewer applications than in 2015. [6].

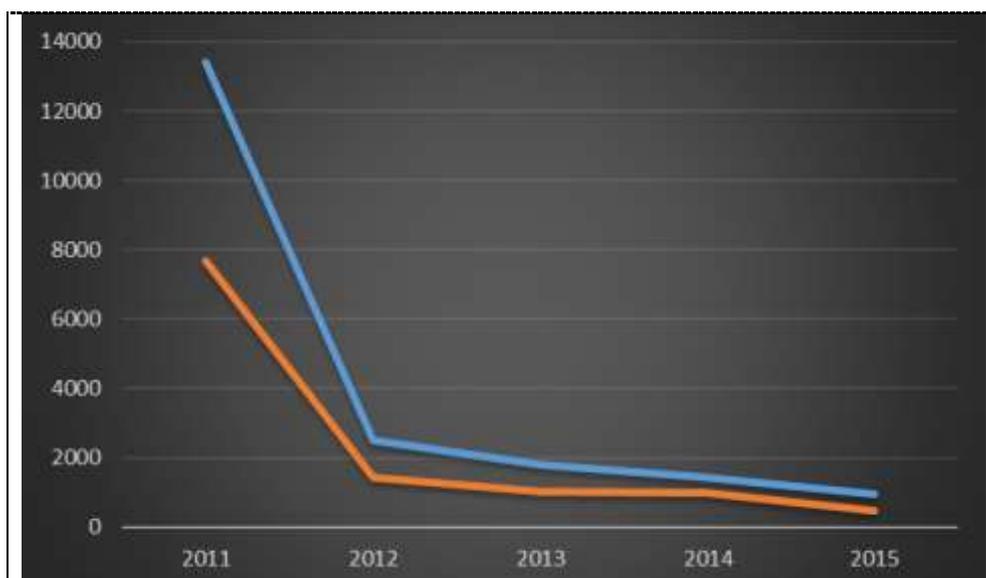
In view of the large number of climate change technologies existing in the field, the study was limited to analyzing inventive activity in the clean energy technologies area.

Among the important trends in clean energy innovation, we identified the following:

Innovation in clean energy technology convergence in general in 2011, as represented by global patenting activity measured in DWPI, was already well-established and significant (13.417 patents) (figure 1).

Five years later, in 2015, patenting activity has diminished by 7% to 939 patent applications. Energy and environmental technologies showed a slowdown in the number of inventions. This was 93% fewer patent applications than in 2011. Clean energy applications fell off dramatically after the late 2011s, while there has been continuous growth in patenting for medical technologies. In 2016 between January and Mai the number of clean energy patents was just 44. The data for 2016 is incomplete but there is no large increase expected.

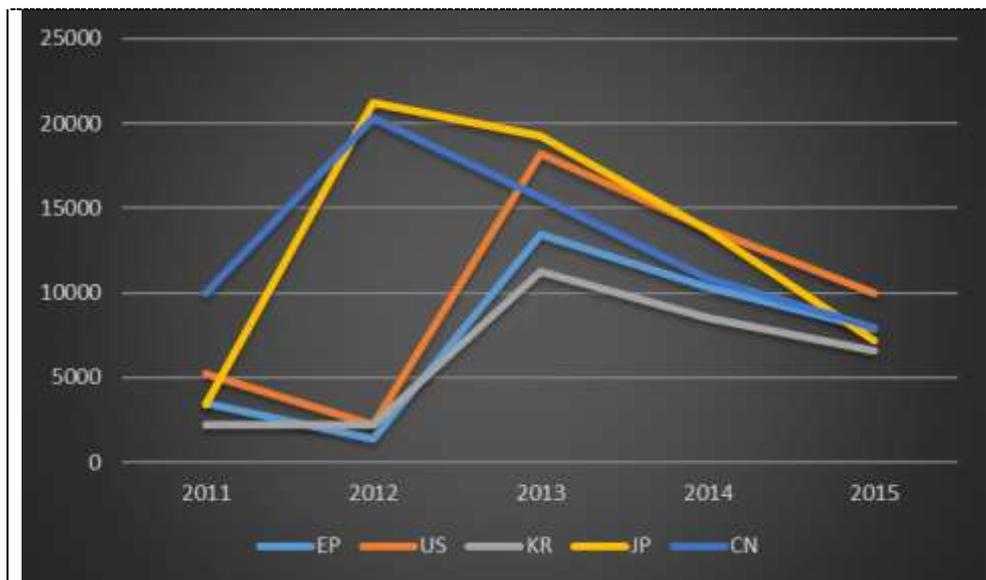
The number of high-value inventions, for which protection is sought at more than one patent office, has diminished still further, from around 7.670 in 2011 to just under 480 in 2015. Worldwide showed the inventive activity in clean energy technologies slowdown in the number of patents applications after 2012.



**Figure 1.** The global inventive activity from 2011 to 2015 in clean energy technology field.

Before analyzing Europe's performance, it is useful to look at overall trends in inventive activity in energy and environmental technologies. Japan is the world's leading region for innovation in the area of clean energy. A sustained increase is apparent in the number of clean energy inventions developed in China, Japan, South Korea, US and Europe. The number of patent applications with a global market perspective patented in China and Korea has increased substantially, but not as much as the number of inventions for which only local protection is sought.

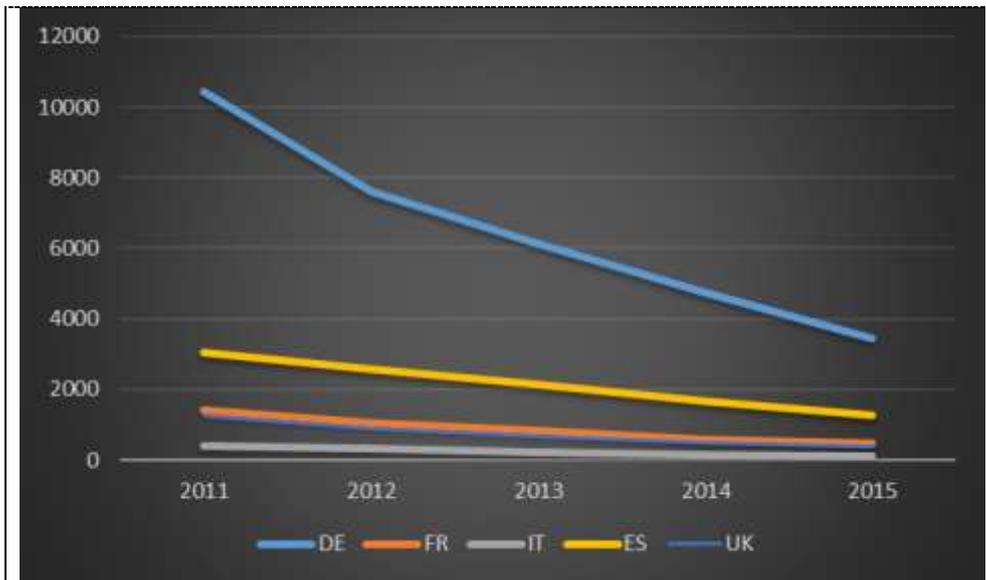
In line with what has been happening at the global level, the annual number of inventions developed by Europe based inventors rose, from 3.503 in 2011 to over 7.877 in 2015 (figure 2). Research in clean energy was very intense and after 2012 has diminished, particularly in Europe.



**Figure 2.** The worldwide inventive activity from 2010 to 2015 in clean energy technology field by country.

Regardless of where inventions occur, they are protected by patents in many additional countries where patent owners hope to obtain some exclusivity in their target markets. The number of filings in EP by outsiders is very large, signaling that Europe will be an important market for the top five applicants.

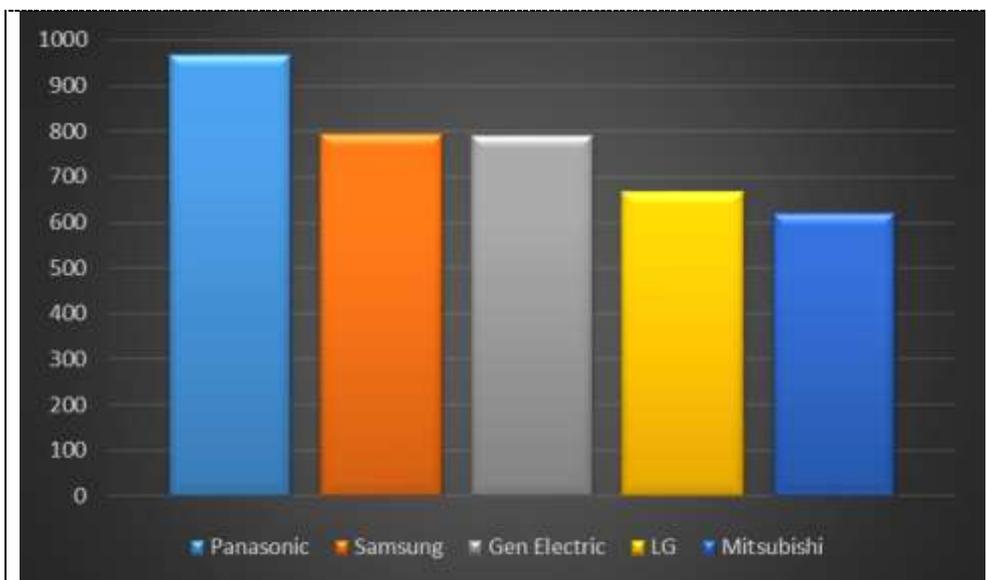
Inventiveness appears highly concentrated within Europe, five countries representing 80% of inventive activity. With almost half of Europe's clean energy inventions in the most recent period, Germany appears as the clear leader in this area, even if other countries are catching up, most notably France, Italy, Spain and UK (figure 3).



**Figure 3.** The inventive activity from 2010 to 2015 in clean energy technology field by European country.

Looking at the clean energy technologies with the highest European inventive activity, it appears that in 2011 in renewable energy Germany’s invention performance is six times greater than that of the inventor country, France.

Research in clean energy was very intense and after 2012 has diminished, particularly in Europe. In 2011 to 2015, the most active companies patenting in the area of clean energy technology are dominated by South Korean, US and Japanese firms, (figure 4).



**Figure 4.** The top five patent applicants in clean energy technology field.

Panasonic are leading providers and has 967 between 2011 to 2015 patent applications, Samsung has 795 patenting activity in this area, Gen Electric 792, LG 666 and Mitsubishi 621. In this context, the European companies have relatively few new clean energy inventions.

## 6. Summary

The knowledge around the newest in each case state of the art and technology trend are at the same time an essential condition for business decision. This knowledge can prevent bad investments with research project and development project, because redundant double inventions are avoided.

Innovation Management, specially strategic management of IPRs is and remains an essential task for companies on technology-related products for supporting managerial decision making. The dynamics of the knowledge economy, the globalization of markets and the increasing complexity of products have also changed the way market actors use IPRs and policy-makers understand IPRs and their role. Furthermore, emerging market economies are increasingly featuring as new players in this game and are adapting their IP policies in order to become pro-active users of the system.

Inventive activity analyses as intellectual property strategy are powerful instruments to identify the new business opportunities and strategic economic investment. The companies with holding strong patent positions in highly attractive technological fields are more successful than those competitors holding weak patent positions in unattractive technological fields.

Inventive activity analysis provides an overview of the patent activity in the technical fields and giving insights into the competitors` pipeline and is a starting point for preparing own product, intellectual property strategies and development efforts. The inventive analysis help to discover new application, serving catalyst a new thinking and creative approaches to business problem or identifying strategic growth opportunities.

The management of Intellectual Property is acknowledged to be closely correlated to a company`s profits. Thus, evaluation for example of inventive activity is an essential task for companies on technology-related products.

With the increasing amount of revenue generated from IPRs, IP management is becoming a strategic component of corporate business operation. IP aims to encourage investment in innovation, by enabling innovators to make a return on their investments. IP also plays an important role in the creation, dissemination and use, for further technological development. The main task of corporate strategy is development of new clean energy technologies, IP protection and commercialization, to provide a corporation with strong competitive advantage to enhance sustained business growth.

## 7. Conclusions

Johnstone et al. examined the effect of environmental policies on technological innovation in the specific case of renewable energy. Only patent data between 1978 and 2003 were used for the study. They found that public policy plays a significant role in determining patent applications [7].

The growth of inventive activity of renewable energy between 1995 and 2011 has been accompanied by an increase in the average economic value of inventions. Our Study shows, that in the next five years was a decline in inventive activity in clean energy technologies.

The knowledge around the newest in each case state of the art and technology trend are at the same time an essential condition for business decision. This knowledge can prevent bad investments with research project and development project, because redundant double inventions are avoided.

A country lacking in raw materials can retain its international competitive ability and the confidence into its technical efficiency only if within all ranges of the private and scientific research technical maximum performances to develop and these as basis for innovation measures also to be used, in pretentious and high-quality products and procedures be thus converted.

We recommend that before beginning of development projects, to determine at the time of whose execution and before patent applications the state of the art. Expensive bad investments and double developments can be avoided thereby. A patent data activity does not however only point those out already admitted solution methods, it can also to suggestions for new solutions lead.

The research and development costs up to 20% can be lowered by the use of patent data bases for research purposes and development purposes up to 25% of the development time to be saved.

Regardless of where inventions occur, they are protected by patents in many additional countries where patent owners hope to obtain some exclusivity in their target markets. The number of filings in

EP by outsiders is very large, signaling that Europe will be an important market for the top five applicants.

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