INTELLECTUAL PROPERTY WITHIN THE EMERGING RENEWABLE ENERGY MARKET: A CASE STUDY OF THE EU*

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Abstract: *Energy produced from renewable sources and its capacity to reduce GHG emissions and to enhance energy security is one of today's most debated issues. The renewable energy sources form a small but fast growing part of the global energy portfolio. A crucial condition for green energy to win an important share of the energy sector is lowering the production cost of the equipments. In the long run this can be achieved by supporting and protecting innovation in this field.*

This paper deals with the debated issue of intellectual property in the field of renewable energy in the European Union. We start with a study of the legislative framework of both intellectual property and renewable energy. Using statistical data and illustrative case studies the paper aims to determine the characteristics and importance of intellectual property in the field of renewable energy. We look at the EU as a regional player and analyse the influence of intellectual property both internally – by presenting the different discourses of developed and developing EU countries - and externally – on global level.

Keywords: renewable energy, intellectual property, European policies
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INTRODUCTION

Energy technologies have a key role to play in providing energy that is at once competitive and sustainable. Technology can bring substantial advances for energy efficiency, the use of renewable energy sources, the reduced use of fossil fuels, the gradual de-carbonization of transport and power stations, and the use of nuclear power. Energy technologies not only play a part in ensuring secure, sustainable supplies at reasonable prices, but also contribute to growth and jobs in Europe (EU Commission 2006). A crucial condition for green energy to win an important share of the energy sector is lowering the production cost of the equipments. In the long run this can be achieved by supporting and protecting innovation in this field.

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1. RENEWABLE ENERGY AND THE EU RENEWABLE ENERGY POLICY

Renewable or alternative energy is any energy resource which comes from natural resources and is naturally replenished over a short time scale. Renewable energy either derives directly from solar energy (solar thermal, photochemical, and photoelectric), indirectly from the sun (wind, hydropower, and photosynthetic energy stored in biomass), or from other natural energy flows (geothermal, tidal, wave, and current energy). It is contrasted with nonrenewable energy forms such as oil, coal, and uranium (Cleveland and Morris, 2009). About 16% of global final energy consumption comes from renewables, with 10% coming from traditional biomass, which is mainly used for heating, and 3.4% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 3% and are growing very rapidly. The share of renewables in electricity generation is around 19%, with 16% of global electricity coming from hydroelectricity and 3% from new renewables.

1.1 Photovoltaic

Nearly all energy forms on Earth come from the Sun, either directly or indirectly. The amount of solar energy the Earth receives every minute is greater than the amount of energy from fossil fuels the world uses in a year. Attempts to harvest the sun‘s energy directly date back to the 1870s when using lenses of mirrors a concentrating solar power system was designed to drive water pumping steam engines. The first solar motor company was founded in 1900. Probably the most familiar kind of solar equipment to most people today are solar hot water systems, which provide domestic hot water, pool heating, and space heating. Another common application of solar energy is photovoltaics, in which using a semiconductor, photons of light are converted into electricity.

The first photovoltaic chip was created in 1883, using a semiconductor made of selenium and gold. In 1954 engineers at Bell Labs discovered the sensitiveness to light of silicon doped with certain impurities. Since then, the technology has steadily improved. Silicon cells today have efficiencies as high as 24 percent, and researchers aim for higher efficiency, lower cost, and greater durability. Traditional solar modules are made with photovoltaic cells made from silicon. The thin-film PV devices are usually based on mixtures of elements other than silicon — most notably copper indium gallium selenite (CIGS) — applied in a thin layer to plastic, even organic, components. The ultimate goal of this PV, however, is what is known as building integrated photovoltaics (BIPV), which incorporates PV directly into roofing and other materials, eliminating solar panels entirely and also function as a roofing membrane. Beyond standard BIPV, a new generation of solar called hybrid photovoltaic/thermal (PV/T or PVT) is emerging, which uses a layer of PV material over a thermal collector to heat air or hot water. This captures more solar energy overall, and it increases the efficiency of the PV layer by keeping it cool. Research into PVT is intensive in the last several years and manufacturers are starting to bring to the market BIPV equipment that can be enclosed in a house design from the beginning (Siegel et al., 2008).

1.2 Wind energy

Wind energy is the energy contained in the movement of air masses; in human energy use traditionally captured by means of the sails of a ship or the vanes of a windmill, and currently by mechanical blades similar to airplane propellers (Cleveland and Morris, 2009). It is the world's fastest growing energy source. The power of wind is a clean and renewable source of energy that has been used for centuries in Europe and more recently in the United States and other nations. Wind turbines, both large and small, produce electricity for utilities and homeowners and remote villages. Wind power dates back to at least 5000 B.C.E., when it was used to propel boats along the Nile River. By 200 B.C.E., simple windmills were pumping water in China and grinding grain in the Middle East.

Windmills designed to generate electricity – turbines - first appeared in Denmark around 1890. Two or three propellers are attached to a rotor, which is connected to an electrical generator, the propeller turns the rotor, spinning the generator and creating electrical current. Utility - sized wind turbines are familiar horizontal - axis units, typically mounted on a tower 75 feet or more off the ground, to take advantage of faster, less turbulent winds. Smaller vertical axis turbines without towers are also used, particularly for low - speed winds (Siegel et al., 2008).

Among the advantages of wind energy we can mention: Wind is a vast, free, and inexhaustible resource. It helps reduce the use of the primary fuels for grid power. Most of the costs are up front to build a wind system, the maintenance and operation costs are minimal and predictable. Financing wind power projects can be low – risk. Deploying more wind reduces climate change. Once in place, a wind farm creates no greenhouse gas emissions and needs no water. Wind power can be a large part of a diversified energy mix. The wind industry is a major economic boost and a source of new jobs.

1.3 Hydro-power and tidal energy

Energy in water can be harnessed and used. There are many forms of hydro energy: hydroelectric energy is a term usually reserved for large-scale hydroelectric dams. Micro hydro systems are hydroelectric power installations that typically produce up to 100 kW of power. They are often used in water rich areas as a remote-area power supply (RAPS). Run-of-the-river hydroelectricity systems derive kinetic energy from rivers and oceans without using a dam.

Tidal power is a form of hydropower that converts the energy of tides into useful forms of power - mainly electricity. Although not yet widely used, tidal power has potential for future electricity generation because tides are more predictable than wind energy and solar power. Tidal power can be classified into three generating methods: tidal stream generator - makes use of the kinetic energy of moving water to power turbines, in a similar way to wind turbines, tidal barrage - makes use of the potential energy in the difference in height (or head) between high and low tides, dynamic tidal power - a theoretical generation technology that would exploit an interaction between potential and kinetic energies in tidal flows.

1.4 Geothermal energy

Geothermal energy is energy in the form of natural heat flowing outward from within the earth and contained in rocks, water, brines, or steam. This heat is produced mainly by the decay of naturally occurring radioactive isotopes of thorium, potassium, and uranium in the earth‘s core (Cleveland and Morris, 2009). Geothermal energy is used to produce electricity or to generate heat. The geothermal plants use steam or superheated water from deep inside the Earth to drive turbines that generate electricity. There are two types of plants: steam plants – which use steam (hotter than 150°C) to turn the turbines that drive the electricity generators and binary plants – which use two fluids to generate steam and are used for lower temperature resources (40 – 150°C).

Geothermal power is one of the cheapest forms of energy, and the cheapest of all forms of renewable energy. It produces nearly 50 times less carbon dioxide, nitric oxide, and sulphur emissions than traditional fossil - fuel power plants. Modern binary cycle geothermal generators have no emissions, not even steam (Siegel et al., 2008).

1.5 Biomass

Biomass is a collective term for all organic substances of non-geological origin that can be used for energy production, including industrial, commercial, and agricultural wood and plant residues; municipal organic waste; animal manure; and crops directly produced for energy purposes. Biomass can be solid (e.g. wood, straw), liquid (biofuels), or gaseous (biogases).

Biomass energy was utilized in 1860 to meet over 70% of the world's total energy needs, mainly via the conventional combustion of wood fuel for heating and cooking. In 2000, the percentage contribution of biomass energy to the world's energy demand had decreased to about 10% of the total. In terms of millions of barrels of oil equivalent consumption per day, biomass energy usage had increased from about 5 out of a total consumption of 7 in 1860, to about 20 out of a total consumption of 200 in 2000.

The purpose of biomass energy applications also increased many-fold during this period and included a wide variety of fuels, organic chemicals, and products. Various projections of the practical global energy potential of biomass energy using advanced combustion, gasification, and liquefaction processes for integrated biomass production bio refinery systems that supply heat, steam, electricity, fuels, chemicals, and bio products on a sustainable basis range up to 100 million toe/day. Commercial systems of this type will be essential in the 21st century if the global community decides that carbon-based fuels and commodity organic chemicals, as well as many specialty chemicals, must be manufactured from renewable biomass resources to maintain the living standards of a modern energy economy, improve environmental quality, and counteract the inevitable shortages and supply disruptions of natural gas and petroleum crude oils expected to start in the first and second quarters of this century. Without large-scale waste and virgin biomass conversion to multiple products in biorefineries, biomass energy utilization will be limited to niche markets, and coal will be the primary source of carbon-based energy, fuels, and commodity chemicals (Cleveland and Morris, 2009).

1.6 EU policy on renewable energies

In order to continue the development and deployment of renewable energy, the EU adopted the 2009 renewable Energy Directive, which included a 20% renewable energy target by 2020 for the EU. The directive provides each Member State with a differentiated legally binding national target to reach the overall 20%, together with a requirement to put in place national policies in order to achieve that national target. Regarding the post-2020 period the agreed framework consists of two elements: the Heads of States‘ commitment to reduce greenhouse gas emissions by 80-95% by 2050, and the directive on the EU Emissions Trading System, which will continue to reduce the emissions cap for the ETS sectors by 1.74% each year beyond 2020. Given the difficulty of reducing emissions to zero in transport or agriculture sectors, achieving the Heads of States‘ commitment is only certain if the power sector emits zero carbon well before 2050 (EWEA, 2011).

Table 1 - Share of renewable energy in gross final energy consumption (%)

geo\time	2006	2007	2008	2009	TARGET
EU-27	9	9.9	10.5	11.7	20
Norway	60.4	60.3	61.9	64.9	-
Sweden	42.4	43.9	44.9	47.3	49
Latvia	31.1	29.6	29.8	34.3	40
Finland	29.2	28.9	30.6	30.3	38
Romania	17.2	18.4	20.5	22.4	24

Source: Eurostat

Table 2 - Share of renewable energy in fuel consumption of transport

geo\time	2006	2007	2008	2009
EU-27	2.1	2.8	3.6	4.2
Slovakia	2.7	4.6	6	8.6
Sweden	4.9	5.9	6.6	7.3
Austria	4.3	5.3	6.1	6.5
Romania	0.8	1.7	1.7	1.6

Source: Eurostat

Steps have been made (Table 1 and 2) but there is a long way to go to meet the 2050 targets.

Energy technology is vital if Europe's objectives for 2020 and 2050 as regards the fight against climate change, security of energy supply and competitiveness of European companies are to be fulfilled. Faced with competition from certain industrialised countries and emergent economies, the European Union (EU) Member States must adopt an effective joint approach on the subject of energy technologies. The strategic energy technology plan (SET plan) presented by the Commission aims to help achieve European objectives and face up to the challenges of this sector:

- In the short term by increasing research to reduce costs and improve performance of existing technologies, and by encouraging the commercial implementation of these technologies;
- In the longer term by supporting development of a new generation of low carbon technologies. An increase in resources, both financial and human, is another major element of the

SET plan. Investment in research and innovation must increase at Community level, through the research framework program (Strategic Energy Technology Plan (SET Plan)).

2. THE EUROPEAN UNION PATENT ENVIRONMENT

One of the central public policy pillars on which the knowledge-based industries and global markets of the 21st Century rest is considered to be intellectual property protection. What‘s more, rapid changes in key technological, policy and social drivers all underscore their growing importance. Furthermore, intellectual property rights (IPRs) spur innovation, stimulate investments needed to develop and market new innovations and diffuse technology and other knowledge in socially beneficial ways (BIAC, 2003). Basically, ―the main goal of an intellectual property system should be to create economic incentives that maximize the discounted present value of the difference between the social benefits and social costs of information creation, including the costs of administering the system" (Maskus, 2000).

Intellectual property is the intangible but legally recognized right to property in the products of one‘s intellect. The three traditionally recognized forms of intellectual property are copyright, trademark, and patent. Copyright protects expressive works— movies, music, plays, books, and the like. Trademark protects marks that are placed on goods to distinguish them from other goods, generally by identifying the maker or distributor. Patent protects inventions. International law also protects less well-known forms of intellectual property, such as trade secrets, know-how, and certain industrial designs (Schwabach, 2007).

Together with the development of new technologies, the ways in which firms protect their innovations and, consequently, the profitability of them have gone through changes. To prevent imitation, firms need to build protective fences around their inventions. These ways of protection can vary from company to company. Some of them can defend their innovations using a patent or some of them can protect their new products using the ―know-how" way. Furthermore, the exclusivity can be also achieved by utilising different mechanisms including institutional protection measures such as copyrights, trademarks, trade secrets and contracts – in other words, the formal means that society provides for innovators to safeguard their creations – as well as the tacit nature of knowledge, human resource management, lead time, and practical and technical means of concealment (Hurmelinna-Laukkanen and Soininen, 2011).

Without doubt, we can affirm that patents play an increasingly important role in innovation and economic performance (OECD, 2004). Moreover, ―patents are a driving force for promoting innovation, growth and competitiveness” (Seville, 2009). Additionally, patents “generate monopoly positions that reduce current consumer welfare in return for providing adequate payoffs to innovation, which then raises future consumer welfare” (Maskus, 2000).

A patent is an exclusive right to exploit (make, use, sell, or import) an invention over a limited period of time (usually 20 years from filing) within the country where the application is made. Patents are granted for inventions which are novel, inventive (non-obvious) and have an industrial application (useful) (OECD, 2004). A patent does more than protect against copying. It prevents even independent devisers of the same idea from using that idea. To balance the strength of this right, a patentee is required to disclose the invention in the patent specification, which is available to the public. In modern systems, patents are intended to encourage innovation, and to promote developments which build on that inventiveness. The aim is that the grant of a patent will act as an incentive to inventors, who will consider the rewards sufficient to make it worthwhile disclosing their invention. Information about the latest technical advances thus becomes available for public consultation, thereby increasing efficiency, and in turn prompting further inventions (Seville, 2009). This presentation of what patent represents is very simple, a summary explanation of a much more complex system.

The patent policy can be used in a various number of ways. On the one hand, patent policy may be used positively, like offering incentives to invent (Seville, 2009). The same idea is also supported by Organisation for Economic Co-operation and Development (OECD), which claims that “viewed from the angle of innovation policy, patents aim to foster innovation in the private sector by allowing inventors to profit from their inventions” (OECD, 2004). On the other hand, “the positive effect of patents on innovation as incentive mechanisms has been traditionally contrasted with their negative effect on competition and technology diffusion. Patents have long been considered to represent a trade-off between incentives to innovate on one hand, and competition in the market and diffusion of technology on the other” (OECD, 2004). Seville (2009) mentions that patent policy “may also be used negatively, for instance to exclude certain inventions from patent protection”. Furthermore, “information exchange is not always positively viewed, and firms may prefer to limit the diffusion of their technology for competitive reasons” (Atallah, 2004).

International and European patent laws

Patents for inventions have their origins in Renaissance Italy, when The Republic of Venice passed a patent law in 1474, whose underlying purpose was to attract men with the incentive of a ten-year monopoly right to their works and devices. Another significant legislative development in patent law came in 1624, when English Statute of Monopolies was adopted (Dutfield and Suthersanen, 2008).

In 1883 the first international convention, the Paris Convention for the Protection of Industrial Property was signed. It is well known that the Paris Convention provides a framework for a number of international patent agreements, including the Patent Cooperation Treaty and the European Patent Convention (Seville, 2009).

In 1970 the Patent Cooperation Treaty (PCT) was signed. It came into force in 1978. Nowadays, it has 144 members, which include ―all the important industrial countries, although somewhat less than the Paris Convention" (Seville, 2009). The Patent Cooperation Treaty makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by filing an ‗international' patent application. Such an application may be filed by anyone who is a national or resident of a PCT contracting State. It may generally be filed with the national patent office of the contracting State of which the applicant is a national or resident or, at the applicant's option, with the International Bureau of WIPO in Geneva (WIPO-PCT, 2012). Filing an application under the PCT is a method of protecting patents in several countries (EU Commission SEC 2011/482).

Obviously, there are more events regarding the development of patents, but the aim of this paper is to highlight the connection between intellectual property and the development of new technologies, in particular renewable energy technologies.

On the basis of a single patent application processed in one of the three official languages of the EPO (English, French or German), inventors and businesses can obtain a European patent for one or more Contracting States to the EPC (EU Commission SEC 2011/482). European patents are granted only to inventions which are new, involve an inventive step, and are susceptible of industrial application. A European patent provides protection for 20 years from the date of filing the application.

According with European Patent Organization's (EPO) official website (EPO-EPC, 2012), 2011 was a record year at the EPO. EPO has received almost 250 000 patent filings, the highest number ever in EPO 34-year history, showing that ―European patents are in high demand across the globe, and that Europe remains attractive for innovative industries".

WIPO has recently drafted a Substantive Patent Law Treaty (WIPO-PCT, 2012). Dutfield and Suthersanen (2008) stated that ―the organisation's Standing Committee on the Law of Patents is currently debating. Such a Treaty would intensify substantive patent law harmonisation in the interests of helping well-resourced companies to acquire geographically more extensive and secure protection of their inventions at minimised cost". As well, ―the Patent Law Treaty (PLT) aims to harmonise and streamline formal procedures in respect of national and regional patent applications and patents, and thus to make such procedures more user-friendly (and cheaper). It was signed in 2000, came into force in April 2005 and is administered by WIPO" (Seville, 2009).

The harmonisation of the national laws remains a real problem for IPR. Even the EPC harmonises the national laws of member states significantly, there are two matters which caused particular concern. According to Seville (2009), those two main problems concern ―the high cost of translating the full patent specification into the national languages of the states where it will take effect" and ―the absence of a common European litigation scheme to deal with infringement and validity of European patents". Consequently, two Intergovernmental Conferences (Paris 1999 and London 2000) sought to address these difficulties, resulting in the London Agreement, and the draft European Patent Litigation Agreement (EPLA).

Community initiatives in the field of patent law

The Commission regards patents as a driving force for promoting innovation, growth and competitiveness within the Community. In spite of this, a little evidence of progress was made in creating a system for a Community patent. In the European Union, patent protection currently can be obtained either through the national patent offices of the Member States, which grant national patents, or through the European Patent Office (EPO) in the framework of the European Patent Convention (EPC). Nevertheless, once a European patent is granted by the EPO, it must be validated in each Member State where protection is sought. For a European patent to be validated in a territory of a Member State, national law may inter alia require that the patent proprietor files a translation of the European patent into the official language of that Member State. Therefore, the current patent system in the EU, in particular in terms of translation requirements, involves very high costs and complexity (EU Commission COM 2011/215, EU Commission COM 2011/216).

EC proposed a new ―Regulation of the European Parliament and of the Council implementing enhanced cooperation in the area of the creation of unitary patent protection" in 2011. The new proposal is accompanied by an impact assessment which identifies the main problems in the current European patent system. First problem which is mentioned is that of high costs related to translation and publication of European patents. Secondly, there are differences in the maintenance of patents in the Member States (annual renewal fees have to be paid each year in each country where the patent is validated). Finally, there is an administrative complexity of registering transfers, licences and other rights related to patents. As a consequence, access to comprehensive patent protection in Europe is so costly and complex that it is inaccessible to many inventors and companies. In particular, small and medium enterprises (SMEs) often prefer an informal protection of their innovations (e.g., secrecy). The situation described has major undesirable effects on the functioning of the internal market. In addition to maintaining the fragmentation of the market, it also has a negative impact on innovation, growth and the competitiveness of European business (EU Commission SEC 2011/482 and 483).

3. THE IMPORTANCE OF IP IN THE RENEWABLE ENERGY SECTOR

The worldwide challenge of climate change mitigation has led to an increased interest in the mechanisms that encourage the development and adoption of new technologies. Because of the recent rapid economic growth, the policy attention has focused on the role of technology transfer and technology development in countries that are not generally on the technology frontier in facilitating the use of clean technologies. Obviously, raising the standard of living in such countries to levels enjoyable without a great deal of energy and environment-related innovation would have detrimental consequences for global warming. Furthermore, it is also true that rapid growth means a great deal of new investment, and new investment is an opportunity for substantial upgrading of technologies (Hall and Helmers, 2010), ICC BASCAP (2011).

In the information age, few people would deny the significance of creativity, inventions and innovation to economic growth and technological development. Over the past two centuries or so, the acceleration of technological advancement has radically changed the life of mankind and demonstrated values of innovation in creating our everyday reality (Wei, 2008).

Without innovation, it will be very difficult and very costly to achieve the transformation to a greener economy. There is vast amount of scientific and empirical evidence that suggests that reducing global greenhouse gases (GHG) emissions will require innovation and large-scale adoption of green technologies throughout the global energy system. How to foster green technologies and innovation is perhaps the most crucial challenge for a green economy. Recent efforts show that OECD governments as well as emerging economies are giving priority to R&D activities and incentives for specific technologies such as renewal energies and environmental technologies (OECD, 2010).

In the context of development, Dutz and Sharma, (2012) define innovation largely as “the commercialization of new ways to solve problems through improvements in technology, with a wide interpretation of technology as encompassing product, process, organizational, and marketing improvements”. Obviously, this definition includes “catch-up innovations, namely the diffusion (both across and within countries) and the adaptation to local context of existing green products, processes, organizational and marketing technologies”. As well, green technologies include a vast range of fundamentally different technologies that support wealth creation and achieve more resource-efficient, clean and resilient growth (Dutz and Sharma, 2012).

Furthermore, Dutz and Sharma, (2012) point that green technologies can be divided in four main groups:

- The first group, regarding pollution reduction and greater resource efficiency, encloses technologies such improved recycling and energy efficiency in buildings (thermal insulation and new materials, heating, energy-efficient lighting), production processes, agriculture, transport infrastructure, and urban design (including land use);

- The second group, regarding climate change mitigation, contains technologies that include cleaner energy supply (wind, solar, geothermal, marine energy, biomass, hydropower, waste-to-energy, and hydrogen fuels), end-use (electric and hybrid vehicles, climate-friendly cement), and carbon capture and storage;

- The third group, regarding adaptation, contains technologies which include more climate-resistant products and processes appropriate for changing environments and tools to understand and insure against climate risks with improved early-warning system processes (sea-walls, drainage capacity, reductions in environmental burden of disease, and water, forest and biodiversity management);

- The last group contains technologies which directly support wealth creation through more sustainable production of plants and livestock, more productive use of biodiversity (natural cosmetics, pharmaceutical products, eco-tourism), and ecosystem protection (Dutz and Sharma, 2012).

A list of environmental patent applications was generated through a new search algorithm developed by the OECD and the European Patent Office (EPO). Fields covered include: renewable energy; fuel cells and energy storage; alternative-fuelled vehicles; energy efficiency in the electricity, manufacturing and building sectors; and “clean” coal (including carbon capture and storage) (OECD, 2010).

In this circumstance, patents play a central role among the different instruments available for protecting innovation (EU Commission, 1997). The current interest in green technology will lead to an increasing invention activity in this area, and, thus, increasing patent interest in this area. Moreover, green technology is being perceived as: usable for marketing, justification for public grants and as necessary and desirable for long-term health, safety and environmental concerns (Hillson and Daulton, 2009). However, more rapid green growth is inconceivable without innovation (Dutz and Sharma, 2012). Furthermore, private research and development (R&D) investment is encouraged through a widely available policy which is intellectual property system (Hall and Helmers, 2011).

The patent is generally viewed as an important instrument for the global economy and is essential when protecting high-tech investments. The patent system extends globally to nearly all countries in the world. More than 170 countries are members of the Paris Convention, and among these countries more than 140 have ratified the Patent Cooperation Treaty (Nielsen et al., 2010).

When it comes to the green patent system, there will be also downsides. The term –green” can relate to: greenhouse gas emissions issues; energy generation, energy efficiency, alternative energy sources, alternative energy uses, environmentally friendly manufacture, environmentally friendly waste disposal, recycling, use of recyclable materials, use of recycled materials, use of materials from renewable resources, repurposing existing materials and equipment, merely using previously wasted energy output from a process for some purpose, waste remediation etc. In this context, anti-patent activists already see patent system as inhibiting implementation of technology, rather than fostering its development. Their position will be that green technology should be available for all to use. Examples of the manifestation of this concern are the global movement for compulsory licensing in third world countries, with respect to green technology; and, in general, an anti-patent movement (Hillson and Daulton, 2009). Furthermore, Haščič et al. (2010) state that environmental policy flexibility is significant in generating innovations. It is argued that –countries with more flexible environmental policies are more likely to generate innovations which are diffused widely and are more likely to benefit from innovations generated elsewhere” (Haščič et al., 2010). This concludes that the role of innovation is important in developing green technologies, but it is strongly influenced by the local environmental policy.

It is well known that not all inventions are patented. An inventor has two options: to bring in front of the public his inventions (requesting a patent for his invention) or to keep it secret (e.g., using industrial secrecy method). Of course, the differences between these two methods of protecting intellectual work are significant. As we have already mentioned, using the method of patent, the inventor can receive incentives from those who are using his invention and can have a strong monopoly over it. Furthermore, patenting their inventions, inventors make their new technologies open to everyone. Using the other option (i.e. industrial secrecy) the new technology is no longer opened to the public. In the green technology field, this detail has many consequences. The human kind is interested in reducing greenhouse gas (GHG) emissions and in mitigating climate change; this reality is confirmed by the numerous conventions signed, like United Nations Framework Convention on Climate Change or the Kyoto Protocol. The same interest is shown by Maskus (2010), who claims that “all countries have an interest in mitigating climate change and seeing global GHGs emission reduced”. Therefore, it is important that the development in the green technology domain must be made public.

3.1 Technologies and specific problems

Photovoltaic technology is a novel technology compared to others like wind-turbines and bio-fuel producing installations. Although costs are declining currently the PV technology is more expensive than traditional means of producing electricity and it requires large-scale precision manufacturing capability. Barton (2007) considers that the industry is moderately centralized. The four leading firms that are producing about 45 percent of the market are based in Europe and Japan (developed countries). In China, the industry has long been encouraged by the government, through support for research into all forms of PV cells and through encouragement of the import or design of PV production equipment. India‘s leading firm is a joint venture between BP Solar (51 percent) and Tata (49 percent). The structure of this industry is clearly an oligopolistic one. It is not clear whether the various patents involved have been taken out in developing nations as well as in developed nations. It is possible that developing-nation firms could copy the technologies for local application or obtain licenses on reasonable terms because of the large number of firms in the industry.

Regarding the Biomass for biofuels, patent issues are likely to arise primarily with the newer technologies, because the older ones are long off-patent, and there is enormous patenting activity in the new areas. Newest technologies in the biomass sector regard creation of new enzymes and organisms that are able to break down cellulose. The economics of bringing the biomass to the production plant favours decentralized conversion. Significant concentration can be observed at the ownership level. In the United States Archer Daniels Midland (ADM), holds 17 percent of the US ethanol capacity and the top five firms hold 37 percent (Barton, 2007).

The basic technology of wind turbines is not new. There are although many recent improvements in the technology like: much lighter and more efficient blades, design of systems (for some styles of mill) to orient the windmill to changing wind directions, mechanisms to protect the system during high winds, and engineering choices needed to decrease long-term maintenance costs. Technology has also been evolving in the design of appropriate systems to enable connection to the electricity grid (Barton, 2007). There are intermediate firms that specialize in building large-scale wind-energy parks, assembling the real estate, the capital and equipment, and making all the necessary arrangements with the electrical grid. The global market for wind turbines however is an oligopolistic market with high entrance barriers – high costs. The leaders in this market are strong and hesitant to share their leading technology out of fear of creating new competitors (Barton, 2007). Because of the high costs involved, newcomers may experience difficulty in obtaining/ creating most advanced technologies.

3.2 Different country approaches

According with Dutz and Sharma, (2012), there has been a significant worldwide increase in frontier green innovation since the end of the 1990s, but most of this is taking place in the high-income countries. Japan, Germany and the USA account for 60 percent of total green innovations worldwide between 2000 and 2005, based on key greenhouse gas (GHG)-mitigation technologies. Furthermore, these three countries plus France and the UK are the top five ‗high-quality' inventor countries, accounting for 64 percent of the world's total high-quality green inventions. China, in tenth place, is the only emerging economy represented among the top ten high-quality innovating countries. In addition, Dutz and Sharma, (2012) point that there are few frontiers green inventions in the developing world, other than in China. During the five year period spanning 2006-2010, countries in the LAC (Latin America and Caribbean), SSA (Sub-Saharan Africa) and MENA (Middle East and North Africa) regions were granted a total of 8, 6 and 3 green US patents, respectively. The EAP (East Asia and Pacific) region, and to a lesser extent S Asia (South Asia) and ECA (Europe and Central Asia) regions have a more sizable output, with 49, 17 and 13 green patents granted. In comparison, high-income countries were granted nearly 1,500 green patents in 2010 alone (Dutz and Sharma, 2012).

According to Haščič et al. (2010) the international diffusion of mitigation technologies and knowledge is a major problem for all countries. It is stated that ―all countries benefit from increased greenhouse gas mitigation arising out of the wide international diffusion of climate change mitigation technologies and knowledge" (Haščič et al., 2010). Moreover, it is claimed that patent data can be potentially used as the base from which to develop a proxy measure of technology transfer. This arises from the fact that protection for the invention may be sought in a number of countries, though patenting is costly.

Developing country governments understand that increased access to technology is one of the pre-requisites of industrialization, self-reliant development, and poverty alleviation. The negotiating positions of developing countries (represented by G77/China) on technology transfer focus on policy mechanisms that prioritise access to advanced technologies. Recent proposals have included funds for technology acquisition, obligatory licensing and funds for buying up IPRs relating to cutting-edge technologies and making them publicly available (Ockwell et al., 2010a).

Developed nations motivation for involvement in the UNFCCC is the mitigation of greenhouse gas emissions. The primary objective of transferring low carbon technologies to developing countries is to achieve rapid and widespread diffusion of these technologies so as to reduce the emissions associated with future economic development in these countries. Developed countries' negotiating positions generally focus on policy mechanisms to diffuse low carbon technologies via, for example, establishing markets for these technologies, or providing market incentives to overcome higher costs (Ockwell et al., 2010a).

Nevertheless, the problem is still controversial. Maskus (2010) observed that there are debates over the scope and limitations of patents. Developed countries view the global IPRs system as -an inducement to the development of environmentally sound technologies (ESTs) and their effective diffusion and transfer to developing countries" (Maskus, 2010). Furthermore, he argues that many developing nations, including China and India, see patents as significant barrier to international technology transfer (ITT). This debate raises some questions regarding the consequence of the patents in green technology transfer process. Certainly, the problem is very complex, the economical component being essential.

Another important aspect to be discussed is that of places where green innovations are developed and where are these utilized.

The success of economic growth in the developing countries comes altogether with more pollution. Therefore, technological innovation is important in ameliorating these environmental impacts. The main problem that emerges is that of diffusion of clean technologies within the developing countries. Because of the increasing quantity of emissions from developing countries, developing policy that encourages the transfer of clean technologies to developing countries has been major discussion point in climate negotiations (Popp, 2009). Haščič et al., (2012) conclude in their study that developing countries such India and China have started to play increasingly important roles in implementing agreements with important implications for the development of climate mitigation technologies. It is pointed out that the objective of these so called ‗implementing agreements' is to ―share knowledge about climate mitigation technologies across borders and creating research collaboration synergies".

Ockwell et al. (2010b) claims that developed countries are interested in encouraging the uptake of green innovations in developing countries due to their public good nature and related potential to reduce and adapt to the impacts of global environmental problems. Moreover, it is recognized that developing countries can take advantage of green technologies developed in high income countries, but both environmental and trade policies will affect the pace and quality of international technology diffusion (Newell, 2009).

CONCLUSIONS

The renewable energy sources form a small but fast growing part of the global energy portfolio. The worldwide challenge of climate change mitigation has led to an increased interest in the mechanisms that encourage the development and adoption of new technologies, also named ―green technologies" or ―renewable energy technologies". Those technologies that support wealth creation and achieve more resource-efficient, clean and resilient growth include: photovoltaic technology, technology for biomass energy, technology of wind turbines, technology for hydro-power and tidal energy, technology for geothermal energy. A crucial condition for green energy to win an important share of the energy sector is lowering the production cost of the equipments. In the long run this can be achieved by supporting and protecting innovation in this field.

The main conclusions we can draw regarding emerging renewable energy market and IPRs are:

1. Green technologies or renewable energy technologies are vital for humankind and play an important role inside the EU, ensuring secure and sustainable supplies at reasonable prices and contributing to growth and jobs in Europe. Consequently, the EU adopted some directives in renewable energy field. On the one hand, the European objectives targets the reducing of costs and improving performance of existing green technologies; on the other hand, the European objectives targets the development of a new generation of low carbon technologies;

2. The role of IPRs in fostering green technology innovation becomes very important. The preoccupation for IPRs is ancient and lasts until now. IPRs spur innovation, stimulate investments

needed to develop and market new innovations and diffuse technology and other knowledge in socially beneficial ways. In this context, the EU regards patents as a driving force for promoting innovation, growth and competitiveness within the member states;

3. There are also different views regarding the scope and limitations of patents. Some annalists claim that many developing nations see patents as significant barriers to international technology transfer, including green patents. In the same manner, anti-patent activists see patent system as inhibiting implementation of technology, rather than fostering its development and aim that green technologies should be available for all to use because reducing pollution is a global objective. Undoubtedly, the concern is complex, the economical component being essential;

4. There has been a significant worldwide increase in frontier green innovation since the end of the 1990s, but most of this is taking place in developed countries. International diffusion of mitigation technologies and knowledge is a major problem for all countries. Developing country governments understand that increased access to technology is one of the pre-requisites of industrialization, self-reliant development, and poverty alleviation. Besides, developing countries have started to play increasingly important roles in implementing agreements with important implications for the development of climate mitigation technologies;

5. Globalization plays a significant role in transferring green technologies to developing countries. Green technologies are first developed in the world‘s leading economies and the access to these technologies is provided by international trade and foreign investments. There are evidences that environmental regulations are adopted more rapidly by developing countries. Additionally, developed countries are interested in encouraging the uptake of green innovations in developing countries, which can take advantage of these green technologies, but both environmental and trade policies will affect the international diffusion of renewable energy technologies.

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