World Trade Institute

MILE 8 PROGRAM

MASTER THESIS

THE ROLE OF INTELLECTUAL PROPERTY FOR THE DEVELOPMENT AND TRANSFER OF RENEWABLE ENERGY TECHNOLOGIES

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Delivered on 29th September 2008

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ABBREVIATIONS AND ACRONYMS

CDM	Clean Development Mechanism
CIEL	Center for International Environmental Law
COP	Conference of Parties of the UNFCCC
DSU	Dispute Settlement Understanding
ESTs	Environmentally Sound Technologies
EU	European Union
EJ	Exajoules
FDI	Foreign Direct Investments
GATT	General Agreement on Tariffs and Trade
GEF	Global Environmental Facility
GHG	Greenhouse Gases
IP	Intellectual Property
IPL	Intellectual Property Law
IPR	Intellectual Property Rights
IPCC	Intergovernmental Panel on Climate Change
IEA	International Energy Agency
IEL	International Energy Law
ICTSD	International Centre for Trade and Sustainable Development
INPI	*Instituto Nacional de Propriedade Industrial* - Brazilian IP Office
MEAs	Multilateral Environmental Agreements
MW	Megawatts
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Co-Operation and Development
OTEC	Ocean Thermal Energy Conversion
PCT	Patent Cooperation Treaty
PV	Photo-Voltaic
R&D	Research and Development
TW	Terrawatts
TRIPs	Trade-Related Aspects of Intellectual Property Rights
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USPTO	United States Patent and Trademark Office
VCLT	Vienna Convention on the Law of Treaties
WBCSD	World Business Council for Sustainable Development
WIPO	World Intellectual Property Organization
WTO	World Trade Organization
WWF	World-Wide Fund for Nature
ZJ	Zettajoules

1. Introduction

The planet Earth's climate change is the most critical phenomenon, in terms of global environmental impact, that arises from the atmospheric pollution. The increasing release of number of gases, including hydro-fluorocarbons, is responsible for the depletion of the ozone layer, which is the greatest contributor to the climate change[1]. Among the factors that generate global atmospheric pollution, energy represents an enormous part of the climate change equation, accounting for at least 80% of global carbon emissions[2].

Moreover, the high costs of oil supply and the current conspiracy of war on terror has created instability and insecurity for all people, either in terms of fuel, food and security. The life cycle of humankind has become attempted by its own creations and industrial achievements. In an era of such insecurity, renewable energy is viewed as a solution that suits the best to modern human society.

Renewable energy technologies are in constant creation, renovation and improvement, through considerable and increasing amounts of investments every year from public or private entities all over the world. Due to this continuous and growing flow of innovation activity, it is likely that the role of Intellectual Property Rights ("IPRs") in renewable energy will also increase.

This paper has the objective to address the use Intellectual Property ("IP") – either by developing or developed countries - as a support mechanism to promote the effective development and transfer of renewable energy technologies, which will consequently enhance technological change and promote worldwide economic growth, coupled with climate change solutions and mitigation of fossil fuel energy dependency.

The Chapter 2 of this paper commences with a description of the international law framework on climate change and transfer of technology. The following Chapter 3 is the most technical

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[1] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment,* Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 50-51.

[2] COSBEY, AARON; ELLIS, JENNIFER; MALIK, MAHNAZ AND MANN, HOWARD *in: Clean Energy Investment – Project Synthesis Report,* International Institute for Sustainable Development (IISD), July 2008, p. 3.

of them, where we describe each source of renewable energy, addressing also new technologies under research and IPRs issues, in special the patent activity related to each technology. We found important to explore in this Chapter some scientific particularities of each renewable source, since IPRs are always related to technological innovations to be employed in the industrial sector, which in case of renewables is very specific. Chapter 4 gives more emphasis to juridical and political aspects involved, discussing the following themes: the IP benefits or barriers to renewable energy technologies; the alternative tools that might be adopted, such as voluntary or compulsory license and technology transfer; and finally the public policies that create the structure necessary to encourage innovative activity and productivity in the area of renewable energies. We conclude our work with some feasible solutions towards the achievement of environmental goals to the reduction of climate change effects.

2. INTERNATIONAL NEGOTIATIONS AND TREATIES ON CLIMATE CHANGE

2.1. Negotiations and Commitments undertaken by Developed and Developing Countries on Climate Change

Concerns with atmospheric pollution, depredation of environment and global warming have become predominant in the international community. Countries are now joining considerable efforts to pursue a global solution for environmental problems related to energy. The main instruments that shape the parameters of International Energy Law ("IEL") are the United Nations Framework Convention on Climate Change ("UNFCCC") that entered into force in 1994, and its associated Kyoto Protocol that came into force in 2005. The UNFCCC's main goal is stabilizing the Greenhouse Gases ("GHG") concentrations in the atmosphere at a level that could prevent dangerous anthropogenic interference with the climate system. The Convention includes provisions (or "protocols") that would set limited mandatory emissions.

The Kyoto Protocol is known as the most important protocol implemented by the UNFCCC, due to its binding characteristic: the ratifying parties have undertaken commitments to reduce their GHG emissions, or to engage in emissions trading if they maintain or increase emissions of such gases. The first commitment period of the Kyoto Protocol ends in 2012. To date, the Kyoto Protocol was ratified by almost all signatory countries, accounting for more than 170 countries, with exception of the US and Kazakhstan. The Protocol establishes 3 categories of countries, divided into different annexes: Annex I (developed countries), which agree to reduce their emissions to levels below their 1990 emissions; Annex II (some of the Annex I developed countries) that have undertaken to provide financial resources for developing countries; and Annex III (developing countries) that have no immediate restrictions or commitments under the UNFCCC.

The innovative system created by the Kyoto Protocol relies on "flexibility mechanisms" that the parties may adopt to achieve their emission reduction targets. The "Join Implementation" ("JI") is one of these mechanisms, through which developed countries may invest in projects in other developed countries, in order to acquire credits to assist assigned amounts. But such acquisition of emission reduction units must be "supplemental" to the domestic actions for the achievement of emission reduction targets. The Clean Development Mechanism ("CDM") is the other flexibility mechanism that allows developed countries to satisfy their carbon dioxide reduction obligations through facilitating an emission reduction in a developing country[3]. The CDM is a market-based trading mechanism that has objective of reducing CHG global emissions through the stimulation of projects in developing countries, in exchange for emission reduction credits[4]. The emission reductions that result from each CDM Project activity held in developing countries must be certified by operational entities.

Through the CDM system, developed countries may find a ready export market for their sustainable energy technologies, including the renewable energy technologies. When a GHG emission reduction project is implemented in the developing countries, the project will receive "carbon credits" that can be sold to Annex I buyers (the so-called "carbon credit market").

In addition to the UNFCCC and Kyoto Protocol, there are some Multilateral Environmental Agreements ("MEAs") that complement the IEL in specific areas. Some of them are also related to climate change, such as: the Asia-Pacific Partnership on Climate Development and Climate, announced on 28th July 2005; the Montreal Protocol on Substances that deplete the

[3] Examples of CDM projects in the energy sector: supply and demand side energy efficiency projects; coal-gas conversion of conventional electricity plant or conversion to biomass; and investment in other renewable energy sources, such as solar energy. MILLOCK KATRIN, *in: Technology transfers in the Clean Development Mechanism: an incentive issue,* Environment and Development Economics 7:449-466, *Centre International de Recherche sur l'Environnement et le Développement* (CIRED), Cambridge University Press, United Kingdom, 2002, p. 453.

[4] WARA, MICHAEL – *Measuring the Clean Development Mechanism's Performance and Potential,* Working Paper, Program on Energy and Sustainable Development, Standard University, July 2006, p. 1-3.

Ozone Layer that entered into force on 01 January 1989; the Vienna Convention for the Protection of the Ozone Layer of 1985; and the Convention on Long-Range Transboundary Air Pollution that entered into force on 16th March 1983.

Non-binding declarations are also important for the IEL because they establish parameters that nations should follow to move towards sustainable development. The 1992 United Nations Conference on Environment and Development ("UNCED") held in Rio de Janeiro was the starting point of five important documents: Rio Declaration; Agenda 21; UNFCCC; the Convention on Biological Diversity; and the Statement of Principles for the Sustainable Management of Forests. The Rio Declaration enunciated several principles for the signatory countries with the objective of establishing a *"new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people"*, and also to implement international agreements that would protect the global environmental and developmental system. On the other hand, the Agenda 21 addressed expressly renewable energy issues, by stating that governments should: (i) develop economic and environmentally sound energy sources, including renewable energy systems; (ii) review current energy supply systems to determine which new renewable energy technologies could be increased; (iii) promote the use of improved energy efficient technologies; and (iv) establish labeling programs for products to inform decision-makers and consumers about opportunities for energy efficiency (Chapter 9.12 (a); (c); (d); (f) and (l) of Agenda 21) [5].

2.2. Treaties providing for Technology Transfer as a solution to Climate Change and Development problems

In several provisions of the UNFCCC, the developed countries are called to assist developing countries through technology transfer, including the provision of financial resources to meet the full incremental costs of Environmentally Sound Technologies ("ESTs"). The countries have committed to *"promote and cooperate in the development, application and diffusion, including transfer of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases"* (Article 4, paragraph 1 (c)); to *"provide such financial resources, including for the transfer of technology, needed for developing country parties to meet the agreed full incremental costs for implementing measures that are covered in paragraph 1 and that are agreed between a developing country"* (Article 3, paragraph 3);

[5] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment,* Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 66-68.

to take *"all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other parties, particularly developing country parties"* (Article 3, paragraph 5 and 7); and to comply with the Article 11 financial mechanism, that is the Global Environmental Facility ("GEF"), *"a mechanism for the provision of financial resources on a grant or concessional basis, including for the transfer of technology"*.

In light of the above mentioned commitments, the Kyoto Protocol states that the parties shall cooperate and *"take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries"* (Articles 10 (c)) and that the developed countries shall also *"provide such financial resources, including for the transfer of technology, needed by developing country parties to meet the agreed full incremental costs of advancing the implementation of existing commitments"* (Article 11 (b))[6].

In view of the implementation of these provisions, the UNFCCC has created the Experts Group on Technology Transfer, which produces reports and makes recommendations to the Subsidiary Body for Scientific and Technical Advice, which deals with a variety of scientific issues. Until now, the work program of the Expert Group has been providing broader access to the information needed to the achievement of technology transfer.

There are other programmes that also implement transfer of technology on environmental issues, such as the GEF, a partnership of the World Bank and the United Nations ("UN"), designed to subsidize developing nations' actions to respond to environmental concerns in situations where these countries have to make expenditures that will not benefit them individually, but the world as a whole. The reduction of carbon emissions for the mitigation of climate change effects is indeed a situation that would benefit the entire world, due to the transnational or ultra-boundary feature of the environment. Thus, the GEF is also involved in renewable energy area, by supporting specially wind and photo-voltaic projects.

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[6] HUTCHISON, CAMERON *in: Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?* University of Ottawa – Law and Technology Journal 3:2, 517 (www.uoltj.ca), 2006, p. 522-523.

In cooperation with the GEF, the World Bank has a Renewable Energy Division that supervises a number of programmes on renewable energy issues.

In the very recent UNFCCC Conference of Parties ("COP") meeting held in Accra (August 2008), it was proposed the establishment of an Institutional Architecture for Technology Development and Transfer, which would ensure the effective implementation of the Convention with respect to commitments relative to development, application, transfer and diffusion of ESTs, practices and processes to support developing countries' capacity building and adaptation of environmental technologies. The purposes of the enhanced action on technology development and transfer are: (i) to make technology accessible to developing countries at most affordable cost; and (ii) to assist developing countries in the development of their own technologies. In order to make more effective and operational the implementation of such purposes, the parties discussed many solutions, such as the establishment of a Subsidiary Body on Technology; a Strategic Planning Committee; Technical Panels and a Multilateral Climate Technology Fund which would use the funds of institutions and would be guided by a Technology Plan of Action[7].

With respect to the non-binding environmental declarations, the Rio Declaration proclaims that countries should cooperate in the exchanges of scientific and technological knowledge, by diffusion and transfer of technologies, among others (Principle 9). Similarly, Agenda 21 emphasizes the reference to the protection of the atmosphere, specifying that activities undertaken to protect the atmosphere should be integrated with the economic and social development, and should take into account the needs of developing countries to the achievement of sustained economic growth and the eradication of poverty (Chapter 9). The 3 areas of the Agenda 21 program have the following purposes: the improvement of scientific basis for decision-making; the promotion of sustainable development through energy development, efficiency and consumption; and the prevention of ozone layer depletion. Several activities are recommended for the improvement of scientific basis for decision-making, such as: promotion and cooperation on research initiatives to the understanding of " *the levels of greenhouse gas concentrations that would cause dangerous anthropogenic*

[7] THIRD WORLD NETWORK (TWN), *Possible Elements of an Enhanced Institutional Architecture for Cooperation on Technology Development and Transfer under the UNCCC,* Briefing Paper 3, Climate Change Talks, Accra, 21-27 August 2008.

interference with the climate system and the environment as a whole, and the associated rates of change that would not allow ecosystems to adapt naturally"[8].

Additionally, a number of bilateral initiatives specific to the climate change area have been undertaken. For example: the US Technology Cooperation Agreement Pilot Program, created in 1997; the US Climate Technology Partnership, replacing the Technology Cooperation Agreement in 2001; the Climate Technology Implementation Plan, created by some countries from the Organization for Economic Co-Operation and Development ("OECD") and the European Union ("EU") in 1995, under the Climate Technology Initiative, which provides for a global network of coordination activities for the renewable technologies; and finally, several EU mechanisms for the CDM finance and technology cooperation, such as the EU-Latin America Clean Development Mechanism Co-operation[9].

3. THE RENEWABLE ENERGY

Renewable energy, also called "green" or "clean" energy (herein considered as synonyms), is being considered a viable solution to the climate change problems, coupled with high oil prices and fossil fuel dependence that the world is recently passing through.

Pursuant to the International Energy Agency ("IEA") in 2002, the renewable energy is *"energy that is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, and bio-fuels and hydrogen derived from renewable sources."*

Renewable energy sources include, for the purpose of this paper: Biomass/Biofuel; Wind; Photo-voltaic/Solar Thermal; Hydropower; Ocean Thermal; Tidal and Wave power; and Geothermal power. The technologies for energy generation can be grid connected or stand alone local grid solutions.

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[8] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment*, Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 66-67.

[9] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Bio-fuel and Wind Technologies,* ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 2-3.

Other forms of low-carbon technologies, including hydrogen, full cells and clean coal technologies will not be subject of our analysis, since they are not considered renewable sources of energy.

The renewable energies are generally sustainable, because they come from naturally replenishing sources. In addition, the environmental and social impacts are generally more benign than those of carbon energies or fossil fuels[10].

Some specialists even make a distinction between "new renewable energy" and "renewable energy". The first ones would be the set of renewable technologies and sources that are environmentally safe and sustainable. This "new renewable" definition would exclude, for example, the large hydroelectric dams from such group, due to the environmental impacts and GHG emissions that they may occasionally result[11]. There are also discussions about Biomass, whether it would be "new renewable" or not, and specific critics over Biofuels, if they would be effectively friendly for the environment, since crops could be used for alimentation, among other arguments. We believe that the various forms of traditionally recognized renewable energy may eventually lead to environmental and human impacts, depending on what technologies used in the various phases of the product life-cycle (production, transport, commercialization, use and disposal) and how is the CHG reaction in each phase. However, such debate would require a complex and scientific analysis of the life-cycle of such products; therefore it is practically beyond the scope of this paper.

An important distinction should be made with regard to the forms of energy, considering its origin. There are 3 commonly recognized "primary energy sources": nuclear power, fossil fuels and renewables. Some advocates of renewables argue that renewable energy technologies are cleaner than fossil fuels and less risky than nuclear power technology. The primary sources of energies are used to the production of the "secondary energy sources", which are: hydrocarbons, hydrogen and electricity. Finally, the secondary sources are the input to the production and provision of "energy services", such as: personal mobility;

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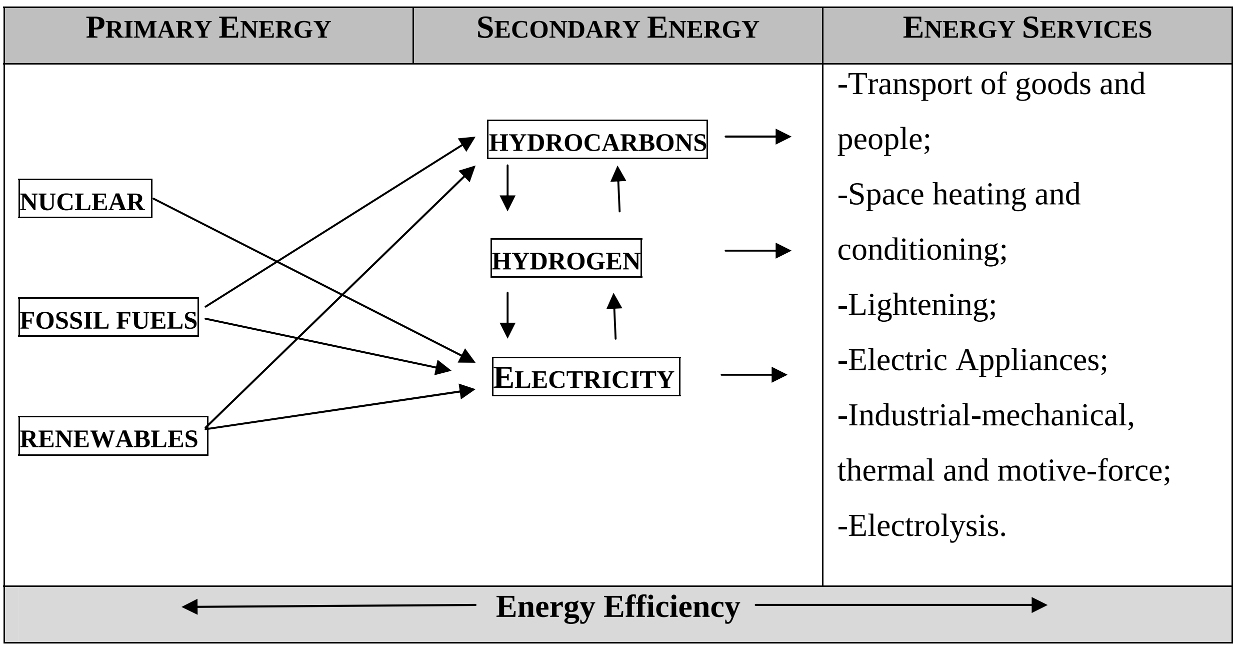
[10] COSBEY, AARON; ELLIS, JENNIFER; MALIK, MAHNAZ AND MANN, HOWARD *in: Clean Energy Investment – Project Synthesis Report*, International Institute for Sustainable Development (IISD), July 2008, p. 3.

[11] MALLON, KARL *in: Renewable energy policy and politics: a handbook for decision-making*, Earthscan, London, 2006, p. 43.

lighting; space heating and conditioning; electric appliances; transport of goods and equipment; industrial-thermal; industrial-mechanical; industrial motive-force; electrolysis etc. Please see the figure below that illustrates the energy system options.

With respect to the transformation of energy from one level to the other, there are multiple ways in which the primary energy sources can produce or be converted into secondary sources (hydrogen, electricity or processed hydrocarbons), but the efficacy of such conversions will vary significantly from one combination to the other. Some forms of renewable energy produce electricity directly (for example, photo-voltaic), and others first provide mechanical energy (hydropower and wind), chemical energy (biomass combustion in a boiler turbine unit), or thermal energy (parabolic mirrors) to generate electricity.

On the other side, biomass can be converted through gasification into hydrogen, and through various processes into gaseous and liquid hydrocarbons, such as ethanol and biodiesel. The electricity from renewables can be used to generate hydrogen via electrolysis of water. The energy efficiency can be increased in all steps of energy production, weather in primary energy production, in the conversion of primary into secondary energy, in the transport and delivery of energy or in the end-use devices used to convert secondary energy into energy services[12]. The figure below can illustrate better the alternatives of energy conversion.



[12] JACCARD, MARK *in: Sustainable fossil fuels: The unusual suspect in the quest for clean and enduring energy,* Cambridge University Press, Cambridge, 2005, p. 19-24, 56-60.

In terms of statistics, it is estimated that in 2004 the renewable energy provided 17 per cent of global primary energy consumption, with predominance of traditional biomass, used for cooking and heating, mainly in rural areas of developing countries. The large-scale hydropower supplied about 16 per cent of the global electricity, and there is still more potential for increasing its production in developing countries. With respect to the so-called "new-renewables", it is estimated that they contribute for about 2 per cent of the world's energy use, but their dissemination displays impressive growth rates[13].

Although renewable energy represents today only a fraction of the current energy use, there is a wide room to be exploited in the future. The technical potential of renewable energy sources is more than 18 times the current global primary energy in 2100, as illustrated in the following table[14]:

The Renewable Energy Resource Base in Exajoules ("EJ") per year			
	Use in 2001[15]	**Technical potential**	**Theoretical potential**
Hydropower	9	50	147
Biomass energy	50	276	2,900
Wind energy	0.12	640	6,000
Solar energy	0.1	1,575	3,900,000
Geothermal energy	0.6	Not estimated	Not estimated
Ocean energy	Not estimated	Not estimated	7,400
Total	60	1,800	4,000,000

The theoretical potential assigned in the table above indicates the amount of energy theoretically available in the planet Earth, as for example, the amount of incoming solar radiation at the Earth's surface, in the case of solar energy. The technical potential is a practical estimation of the quantities that could be effectively used by humankind, considering

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[13] JOHANSSON, THOMAS B; MCCORMICK, KES;NEIJ, LENA and TURKENBURG, WIM C. *in: The Potentials of Renewable Energy*, A Global Review of Technologies, Policies and Markets, Edited by Dirk Abmann, Ulrich Laumanns and Dieter Uh, Earthscan, , United States, 2006, p. 15-18.

[14] ROGNER, HANS-HOLGER *in: World Energy Assessment,* Chapter 5: Energy Resources (table 5.26), 2001, available at the UNDP website: http://www.undp.org/energy/activities/wea/drafts-frame.html.

[15] The use described is in primary energy equivalent. For comparison, the global primary energy use was 402 EJ per year in 2001.

conversion efficiencies of the available technology and land area. For instance, the estimation for solar energy assumes that 1% of the global unused land surface is used for solar power[16].

The IEA's World Energy Outlook projects that all renewable energy use in developing countries will increase by 35% until 2020, especially Hydropower, while in developed countries other forms of renewable energy are expected to grow faster, like Biomass, Wind, Solar and other non-hydropower renewables, due the availability of suitable sites. The following table has more details on the expected growth of renewable energy per world regions.

Table: Total Primary Energy Supply of Renewable Energy by Region (Mtoe)[17]

	1997	**2020**
World	410	697
OECD	286	434
• **Europe**	106	190
• **North America**	150	191
• **Pacific**	30	53
Transitional Economies	23	32
Developing Countries	101	231
• **China**	17	56
• **East Asia**	15	49
• **South Asia**	9	20
• **Latin America**	53	91
• **Middle East**	2	4
• **Africa**	6	11

* Figures do not include bioenergy in developing countries.

An important factor for the growth trend of renewables is the decrease of prices of these energies for consumers. Although they are still currently more expensive in terms of cost-

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[16] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 12.

[17] IEA *in: World Energy Outlook* 2000, OECD/IEA.

efficiency than fossil fuels, the tendency is that prices drop down while the technology is constantly improved and the competition is increasing in the market.

3.1. The importance of Renewable Energy to the Reduction of Fossil Fuel dependence

Further to the objective of *"stabilization of greenhouse gas concentrations in the atmosphere"*, the adoption of renewable energies by a country usually is coupled with the aim to minimize or exclude its dependency of fossil fuel energy sources. The present energy system is heavily dependent on fossil fuels, which only exist in few regions of the world. In terms of numbers, the coal, oil and gas accounted for 78% of primary energy consumption in 2002. Due to such dependence on imported fuels, many countries are vulnerable to disruption in supply, what might result in economic damages and negative effects on their balance of payments[18].

The high oil prices and the exhaustive characteristic of fossil fuels are, therefore, important reasons for the increasing development and commercialization of renewable technologies.

The countries are now becoming aware of the importance of diversification of energy supply, including development of renewable energy, energy security and prevention of conflicts about natural resources. The US electric power industry, for example, relies on large, central power stations, including coal, natural gas, nuclear and hydropower plants, which together generate more than 95% of the nation's electricity. Over the next few decades, renewable energies are expected to participate actively in US electric power industry, due to the intensive research activity and capital invested in this area[19].

In fact, renewable energies are receiving more government support, enactment of specific legislations and financial incentives, either by public or private sector. Investment capital flowing into renewable energy climbed from $80 billion in 2005 to a record $100 billion in 2006[20].

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[18] GOLDEMBERG, JOSÉ *in: The Case for Renewable Energies*, Renewable Energy – A Global Review of Technologies, Policies and Markets, Edited by Dirk Abmann, Ulrich Laumanns and Dieter Uh, Earthscan, , United States, 2006, p. 5, 8-9.

[19] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 16.

The investments in renewable energy come from both public and private sectors, including capital incentives and loans from banks, private investors, venture capital funds, as well as public financial incentives and loans from governments and central banks. Most of the investments are still occurring in developed countries or large developing countries, like China, India and Brazil[21]. Nevertheless, the increase flow of investments in renewables is a worldwide tendency, particularly due to the generalized need of substituting fossil fuel dependency.

At the same time, improving energy efficiency represents the most immediate and cost-effective manner to reduce fossil fuel dependence, to provide energy security and to reduce health and environmental impact of the energy sources. Improved energy efficiency could make renewable energy sources more affordable and practical for the market.

3.2. Forms of Renewable Energy Technology and IP issues related thereto

3.2.1. Biomass and Biofuels

3.2.1.1. Overview

Biomass is a term used to define a number of energy products that derive from photosynthesis, such as plants, crop residues, woodmill wastes, animal manure, forestry residues and municipal solid wastes. The so-called "first-generation" biofuels are the traditional crop-based ones, while the "second-generation" are those biofuels based in newer technologies that derive from waste, algae or other non-food vegetation.

When plants grow, the process of photosynthesis uses the solar energy to convert carbon dioxide into carbohydrates, which are the organic compounds that compose biomass. When plants die and decay, the energy stored is released in carbohydrates and discharges carbon

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[20] UNITED NATIONS ENVIRONMENT PROGRAMME AND NEW ENERGY FINANCE LTD., *Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries*, p. 3.

[21] COSBEY, AARON; ELLIS, JENNIFER; MALIK, MAHNAZ AND MANN, HOWARD *in: Clean Energy Investment – Project Synthesis Report*, International Institute for Sustainable Development (IISD), July 2008, p. 12-13.

dioxide back into the atmosphere. Biomass is therefore considered a renewable energy source because the growth of new plants replenishes the energy supply[22].

The solid biomass is usually used directly as a combustible fuel, producing heat by burning. In many developing countries the solid biomass is the major fuel source for heating and cooking, where people do not have access to modern energy technologies. It is still the main source of energy for almost half of the world's population[23].

On the other hand, biomass (wheat, corn, sugar cane, sugar beets) can be fermented to produce ethanol. Methanol can also be produced by distillating biomass. Both methanol and ethanol are used as fuel for transportation (biofuels), and can be blended with petroleum derivatives. The exploitation of ethanol as a biofuel started in Brazil since 1976, through a domestic large-scale program of planting sugar cane and cassava for the ethanol production. Nowadays, 70% of all engine vehicles in Brazil rely on ethanol rather than petrol derivatives[24]. The United States ("US") have also developed an intensive program of ethanol production with corn plantations. However, empirical studies consider the corn a less efficient input than sugar cane with respect to energy production. In parallel, the EU is using in an alternative process, which is the diesel fuel (biodiesel), manufactured from a variety of biomass forms, in a different process[25].

Other countries also produce ethanol as a biofuel, like India, United Kingdom, Europe and Zambia. Specialists consider ethanol an emerging source of energy in the market, with empirical indications that global trade in ethanol is likely to grow[26].

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[22] RENEWABLE ENERGY FOUNDATION, available at the website: http://www.renewableworldfoundation.org/bio.html.

[23] JACCARD, MARK *in: Sustainable fossil fuels: The unusual suspect in the quest for clean and enduring energy,* Cambridge University Press, Cambridge, 2005, p. 23.

[24] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment,* Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 22-23.

[25] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Bio-fuel and Wind Technologies,* ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 12.

[26] GUEYE, MOUSTAPHA KAMAL *in: Biofuels Production, Trade and Sustainable Development: Legal and Policy Issues,* ICTSD – International Centre for Trade and Sustainable Development, event organized by ICTSD & SEI, Bali, 04 December 2007.

Indeed, the potential range of ethanol exploitation is broad. For instance, Brazil has pioneered the construction of is the first ethanol-powered fixed-wing aircraft by an Embraer[27] subsidiary located in the State of São Paulo. The *Embraer EMB 202 Ipanema* airplane is widely employed in Brazil as an agricultural aircraft, used for aerial application, particularly crop dusting. This invention demonstrates that ethanol is a possible solution as a fossil fuel substitute in the aviation sector[28].

3.2.1.2. IP issues regarding Biomass and Biofuels

With respect to the IP issues, there are many technologies under development in the field of biomass, which might result in future patent registration and license of technology.

Researchers are now analyzing the possibility of using microalgae as an energy source, with applications for biodiesel, ethanol, methanol, methane, and even hydrogen.

Active research work is also being carried out on more efficient methods of converting biofuels into electricity using fuel cells. This technology would require the breaking down of cellulose. To date, this has happened only as a demonstration by the apparent leader Canadian corporation, Logen. In the website of this firm, it is informed that the enzymes under testing will be available for sale together with technology licenses in the future.

Moreover, specialists are now studying new organisms to manage chemical pathways needed for the new feedstock. There may be special plant crops for this reason, and theses plants might be bioengineered. They are also researching the possibility of using algae to produce biomass energy.

The technologies for the use of biofuels in automotive engines are in the market since long time, but constant developments and special designs are needed, as well as special additives to enable engines to use particular new fuels. The "Flex Fuel" is a new technology, largely utilized in Brazil, which allows vehicles to shift from gasoline to ethanol in its normal

[27] Embraer – *Empresa Brasileira de Aeronáutica* (Brazilian Aeronautic Company). CASSIOLATO, JOSÉ; BERNARDES, ROBERTO and LASTRES, HELENA *in: Transfer of technology for successful integration into the global economy: a case study of Embraer in Brazil,* United Nations, New York, 2002.

[28] WIKIPEDIA website, available at: http://en.wikipedia.org/wiki/Embraer_EMB_202_Ipanema.

utilization. Such technology is already patented[29]. A research in WIPO patent database has found 5 patent records related to the term "flex fuel"[30]. In the Brazilian IP Office (INPI), a search with the terms "fuel", "ethanol" and "engines" encountered 79 patent records[31].

Moreover, there are private and public funded efforts for the development of new processes, enzymes or microorganisms to produce biofuel, which are not readily available in the market. This means that other patents and utility models will be registered in the future, and the holders of such rights will be willing to license their technology. However, due to the competition among biofuels and other alternative fuels, some specialists deem unlikely that the licensing fees for such technology transfer will remain high for very long[32].

The aviation technology for construction of ethanol-powered aircrafts also promises a number of new IPR registrations and negotiations for the future. This exceptional use of biofuel energy might be seen as solution for the fossil fuel dependency on the aviation sector.

3.2.2. Wind

3.2.2.1. Overview

The wind power is the use of kinetic energy in airflows to run wind turbines and produce electricity**.** It is considered a renewable energy source since is self-replenishing and produces no GHG during its operation.

Compared to the other renewable sources, the wind power is the one that has grown more intensively in the last decade. Its annual growth rate is near 30% per year, although it currently provides less than 0.5% of global energy. Such scenario is a result of rapid advances

[29] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Bio-fuel and Wind Technologies*, ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 12.

[30] WIPO patent database, available in the website: http://www.wipo.int/pctdb/en/.

[31] INPI patent database, available at the website: http://pesquisa.inpi.gov.br/MarcaPatente/jsp/servimg/validamagic.jsp?BasePesquisa=Patentes.

[32] BARTON, JOHN H. *in: Patenting and Access to Clean Energy Technologies in Developing Countries*, WIPO – World Intellectual Property Magazine, February 2008, p. 1.

in wind turbine technology, which maximizes energy generation efficiency, especially with reduction of maintenance and mechanical problems and with the increasing of turbines size. As a consequence, many developed countries and some developing countries have constructed the so-called "wind farms", sometimes with hundreds of turbines[33].

Although the technology of windmills is not new, there are many recent and potential improvements in the current technology. It is believed that the long-term potential of wind power is 5 times the current global energy production, or 40 times the current electricity demand[34]. It is estimated that 72 TW (terrawatts) of wind energy on the Earth have the potential to be converted into electricity, commercially practicable[35].

The wind-driven rotor works at a variable speed, depending on the wind condition. The rotor may drive a generator directly or through a fixed-radio gearbox, and the frequency of any alternating current produced by the generator varies, depending on the wind speed. The electricity produced by the generation has to be brought to the frequency of the grid and must satisfy its standards to protect against some failures from the mill[36].

There are other examples of some technologies being developed: the design for windmill, which has to be lighter and with more efficient blades; the design of systems to orient the windmill to change direction according to the wind; mechanisms to protect the system from high winds; engineering solutions to decrease the long-term maintenance costs; development of a cheaper form of large-scale electricity storage; implementation of high-voltage direct current technology; combination of wind power with other power sources to increase efficiency etc.

The market demand is trending towards larger machines that enable economy of scale and less visual impact on the landscape. Offshore wind power plants have demonstrated less

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[33] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment,* Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 19-20.

[34] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 3-4.

[35] RENEWABLE ENERGY FOUNDATION, available at the website: http://www.renewableworldfoundation.org/wind.html.

[36] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Bio-fuel and Wind Technologies*, ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 15.

visual impact and significant energy capacity. Experiences registered offshore wind speed of 90% greater than that of land. The wind speed could also increase with higher altitude or with airborne wind turbines[37].

3.2.2.2. IP issues regarding Wind

In the wind sector, the market power is very concentrated. The top four companies have almost 75% of the market. Due to this fact, it is even more difficult, especially for developing countries, to enter in the global market for wind turbines without significant IP costs. The current owners of the wind technology may be hesitant to share their technology, fearing the potential creation of new competitors.

There are many registered patents with relation to wind power, especially in developed countries. In the US, for example, The United States Patent and Trademark Office ("USPTO") has accounted for 173 patent records, just with a search on the terms "variable speed" and "wind turbine". Examples of some technologies already patented: (i) method of controlling the inverter in order to provide a most effectively power to the grid; (ii) strategy of controlling the turbine speed; (iii) patents on variable speed technology to use with wind turbines; (iv) patents for wind turbine control technologies, among others.

Additionally, significant patent disputes and licensing discussions have occurred in his sector, mainly concerning the US market. Companies are starting to use the patent strategy as an important tool to increase and maintain their market share.

Some government research programmes are also being held, mostly in developed countries, which will probably result in new patents and utility models. As an example, the US National Renewable Energy Laboratory lists 6 patents that may be soon registered, including patents on airfoil design and on variable speed power and generator systems[38].

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[37] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 4.

[38] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Bio-fuel and Wind Technologies*, ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 15-17.

Among the developing countries, China and India have succeeded in wind energy production industries over the last decade. The Indian leading firm has even acquired some developed country's company competitors, in order to obtain the technology and increase its position in the market[39].

3.2.3. Photo-Voltaic and Solar Thermal

3.2.3.1. Overview

The potential of solar energy on a worldwide basis is remarkable. The total solar energy available to the Earth is approximately 3850 ZJ (zettajoules) per year. It is estimated that the sunlight that reaches every day the Earth is sufficient to satisfy the humankind's energy requirements for at least 15 years[40]. But the choice of solar energy technology will depend on several factors, such as the availability of efficient and low-cost technologies, high-efficient end-use technologies and effective energy storage technologies.

The solar energy can be used to produce electricity, steam, heat, cold, light, ventilation or hydrogen.

Solar heating and cooling systems can be generated by 2 types of systems: the active and passive systems. The active system requires solar collectors, which are installed to capture solar energy that is conveyed to the space or water to be heated or cooled. The solar radiation is converted into thermal energy, which will be used to heat a working fluid (whether air or water), and will further be transported to the end-use area (space or water heating or cooling).

In other hand, the passive system seeks to control temperature not by employing solar collector panels or mechanical devices, but by the architectural features of the building itself (windows, walls, ceiling etc.).

Electricity can be generated either by solar thermal or photo-voltaic ("PV") conversion.

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[39] BARTON, JOHN H. *in: Patenting and Access to Clean Energy Technologies in Developing Countries,* WIPO – World Intellectual Property Magazine, February 2008, p. 2.

[40] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment,* Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 16.

The solar thermal systems that produce high temperature heat can be used to generate electricity. In the solar thermal conversion system, the radiation of the sun is used directly or via a heat exchanger to generate steam, which will drive a conventional steam turbo-generator plant and will consequently produce electricity[41]. Some examples of solar thermal electricity are the solar power towers, the parabolic through system and parabolic dish systems.

The PV systems also produce electricity by direct conversion of solar light to electricity. The most important component of the PV system is the solar module, composed by a number of PV cells, connected in series. These cells are made of materials classified as "semi-conductors", such as wafer of crystalline silicon coated on each side with boron and phosphorus, that when exposed to sunlight, releases electrons, which will result in an electric current. There are many different types of solar cells currently under development in the solar industry. The thin-film technology is the one that has offered, so far, the best long-term prospectus for lower costs of production and a return on energy investments of less than a year[42]. There are some advantages of PV system. For instance, the system requires no moving parts, little maintenance, no fuel and it does not create any sort of pollution. In addition, the silicon that composes PV cells is found in abundant quantities in the world, although the manufacturing of PV cells, in a pure monocrystalline form, requires high technologies and costs. Such costs of PV energy, overall, have declined at least two times the last decade[43].

The newest challenge project with solar power is being carried out in Switzerland by a team of more than 50 specialists from six countries. They are working on the construction of an airplane based solely on the energy collected by the solar energy cells. Their goal is to make a flight around the world with this 80 meters wingspan airplane in the year 2011[44].

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[41] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment,* Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 17.

[42] JOHANSSON, THOMAS B; MCCORMICK, KES;NEIJ, LENA and TURKENBURG, WIM C. *in: The Potentials of Renewable Energy,* A Global Review of Technologies, Policies and Markets, Edited by Dirk Abmann, Ulrich Laumanns and Dieter Uh, Earthscan, , United States, 2006, p. 24-25.

[43] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Bio-fuel and Wind Technologies,* ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 9.

[44] SOLAR IMPULSE information available at the website: http://www.solarimpulse.com/en/challenge/index.php?idContent=308&idIndex=7.

3.2.3.2. IP issues regarding Photo-Voltaic and Solar

There is a significant public sector support in the Solar Energy research and technology. As a consequence, the probability for future patent inventions or utility models is considerably.

The industry of PV systems is quite decentralized, although the production of PV panels is still quite expensive and requires complex technology. The PV manufacturing equipment industry is also decentralized, and there are already many patents registered in this area. There will be certainly other patents or utility models on parts of the production process, since the investments are continually growing, and companies are developing different technologies.

Newer thin-film technologies will certainly be subject of new patents, which might result in future litigations. There have already been patent litigations concerning amorphous silicon PV cells and PV applications as hand-held calculators and night vision equipment.

Another area in which there might be new patents or utility models is the inverter production industry. Inverters are the equipment needed to convert the direct current power produced by the panels into alternative current devices. They are extremely important and reflect a high portion of the total cost of the system. The inverter industry appears to be more concentrated than the PV industry, but each industry and each location have differences in regulatory requirements and markets. Considering the declining of the PV technology costs, some specialists deem that the royalties for patent licensing in this sector also tend to have declining value[45].

The challenging construction of an airplane with solar power is a high-specialized technology project that promises a number of new IPR registrations, negotiations and disputes in the future.

With respect to the transfer of technology from developed to developing countries, it is likely that the licenses on solar energy will be conducted on reasonable terms and values, since there

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[45] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Bio-fuel and Wind Technologies*, ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 9-11.

is already a large number of firms in the industry. China and India are examples of developing countries that have reached the solar energy market, either through license of technology or joint ventures formation[46].

3.2.4. Hydropower, Ocean thermal, Tidal and Wave Power

3.2.4.1. Overview

The density of water is about 800 times larger than the air; therefore even a slow flowing stream of water or swell of sea may produce a great amount of energy.

The water power is considered a renewable energy source, since it produces no significant pollution or atmospheric carbon emissions, although its utilization has been source of critics from some environmentalists, especially with regard to the flooding of lends needed for hydroelectric dams.

We have used the term “Hydropower” to mean the production of electricity by means of mechanical conversion of the potential energy of water in high elevations. The hydropower can be found in basically 2 different systems: The Hydroelectric and the Micro hydro systems.

The Hydroelectric is the most utilized form of hydropower. Since at least one century the societies (mostly the industrialized countries) have used hydropower’s mechanical energy to spin electricity-generating turbines[47]. The “Hydroelectric” term herein used is associated with large-scale hydroelectric dams, such as the Akosombo Dam in Ghana and the Grand Coulee Dam in Washington State, US. The biggest Hydroelectric power plant of the world is the Itaipu, constructed in Rio Parana, in the areas adjoining the border between Brazil and Paraguay. The Hydroelectric power supplies currently about 715,000 MW (megawatts), the equivalent of 19% of the world electricity. In the US, only about 10% of the energy produced is derived from hydropower and only 20% of the nation’s hydropower potential has been developed. The electricity is produced by spinning electromagnets within a generator’s wire

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[46] BARTON, JOHN H. *in: Patenting and Access to Clean Energy Technologies in Developing Countries,* WIPO – World Intellectual Property Magazine, February 2008, p. 1.

[47] JACCARD, MARK *in: Sustainable fossil fuels: The unusual suspect in the quest for clean and enduring energy,* Cambridge University Press, Cambridge, 2005, p. 22-23.

coil, which creates a flow of electrons. To keep the electromagnets spinning, falling water is used. The kinetic energy of falling water is then converted into electricity[48]. Advanced technologies can increase the energy output of large-scale hydropower dams at essentially unchanged water flows.

The Micro hydro systems is the term used here in reference to small-scale hydropower dams. The basic technology used in micro hydro dams is the same as hydroelectric large-scaled dams, but the small dams produce less power, and are often used in water rich areas. Example of small dam is the installation in Solomon Island.

We could also add a third form of hydropower, the "Damless hydro systems", which derive kinetic energy from rivers and ocean without using a dam[49]. Since dams represent up to 80% of the costs and most of construction complexity of conventional hydropower, the damless system promises to reduce costs and shorten construction process. Due to the environmental concerns of large and small scale hydropower, the Damless systems are becoming an interest alternative, especially in developed countries. The US are currently developing damless projects in Washington State and New Hampshire.

The Ocean thermal, Tidal and Wave Power are considered the 3 types of Ocean energy resources under development.

The Ocean Thermal Energy Conversion ("OTEC") exploits the natural temperature differences in the sea - from the warmer surface to the colder lower recesses - by using a form of cyclic heat engine. But for the effectiveness of the operation, the thermodynamics law requires a large temperature difference of approximately 20°C to deliver a technically and economically feasible system. This means that the surface temperature of the ocean near the coast-line must be a minimum of 27°, and the ocean height in this area must be deep enough, which are features that in practice only some tropical regions may have[50]. Hawaii has experimented OTEC power since the 1970's. But there is no large-scale operation today, since

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[48] RENEWABLE ENERGY FOUNDATION, available at the website: http://www.renewableworldfoundation.org/hydro.html.

[49] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 4-5.

[50] JOHANSSON, THOMAS B; MCCORMICK, KES;NEIJ, LENA and TURKENBURG, WIM C. *in: The Potentials of Renewable Energy,* A Global Review of Technologies, Policies and Markets, Edited by Dirk Abmann, Ulrich Laumanns and Dieter Uh, Earthscan, , United States, 2006, p. 28-29.

the OTEC systems are not very energy efficient. Pumping water and the transport of electricity to land are huge engineering challenges for OTEC. The technology needs to pipe large volumes of water from the seabed to a floating system, and also needs a huge area of heat exchanger. In parallel to this, the system faces difficulty of transmitting energy from a floating device in deep water to the shore[51].

The Tidal power captures energy from the ocean tides flow. There are two-way systems that generate electricity on both the incoming and outgoing tides. Tidal Barrage is the first system that can change the tidal level in the basin and increase turbidity in the water. The technology is exploited commercially at La Rance, in France, and in the Bay of Fundy, Canada. Some specialists consider the Tidal power not environmentally-friendly and not so efficient, due to the low energy intensity of the water flow and low rate of capacity utilization during slack and slow periods and the distance from the electric grid to the best sites, which would make the technology more expensive[52]. Tidal Fence is the other system that can also harness the energy of tides. A tidal fence system has vertical axis turbines mounted in a fence. When the tides come in, the water levels in a basin are raised. The tides than roll out, and when the tide is low, the water in the basing is discharged through a turbine. A tidal fence is planned for the San Bernardino Strait in the Philippines.

Another technology under development is the Tidal Stream Power, which captures energy from the flow of tides, using underwater plant that resembles a small wind turbine. The stream devices convert energy in tidal currents into electricity through the use of slow rotating turbines. Because water is about 800 times denser than air, tidal turbines will have to be much sturdier than wind turbines. They will be heavier and more expensive to build but will be able to capture more energy. The project demonstration of Tidal Stream Power already exists in Strangford Lough, Northern Ireland[53], but it is currently in experimental stage[54].

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[51] JOHANSSON, THOMAS B; MCCORMICK, KES;NEIJ, LENA and TURKENBURG, WIM C. *in: The Potentials of Renewable Energy*, A Global Review of Technologies, Policies and Markets, Edited by Dirk Abmann, Ulrich Laumanns and Dieter Uh, Earthscan, , United States, 2006, p. 19.

[52] JACCARD, MARK *in: Sustainable fossil fuels: The unusual suspect in the quest for clean and enduring energy*, Cambridge University Press, Cambridge, 2005, p. 24.

[53] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 5.

[54] MCDONALD, HENRI *in: Tidal Power comes to Northern Ireland*, guardian.co.uk, March 31 2008, available at the website: http://www.guardian.co.uk/environment/2008/mar/31/tidal.power.

The Wave Power is the utilization of waves to produce energy. The total grid-connected wave power is very small. It consists of several oscillating water column devices, a technology that is under development. New larger oscillating water columns are also being developed[55]. There are some prototype systems actually working, and the technology is starting to be used commercially. A positive aspect of the wave energy is that it is continuously available in nature, although the intensity of waves may vary by season. A wave energy scheme has been installed in Australia, generating electricity with 80% availability factor. But the first world's commercial wave farm is the *Aguçadora Wave Park* in Portugal, established in 2006. Scotland also announced in February 2007 the funding of a new wave farm, which would be the world's largest with a capacity of 3MW generated by four Pelamis machines[56].

In addition, there are other new technologies under research, such as the "Blue energy". Such technology is the reverse of desalination, which utilizes the difference in salt concentration existent between seawater and river water[57]. This gradient difference may generate electricity by separating positive and negative ions by ion-specific membranes, producing the Brackish water. The tests on pollution of the membrane are in progress, and the blue energy is not yet in the market. There are two projects under development, one in the fiord south of Oslo, Norway, and the other at a seaside lake of Netherlands[58].

3.2.4.2. IP issues regarding Hydropower, Ocean thermal, Tidal and Wave Power

The Hydroelectric hydropower generation is actually a mature technology. For this reason, it is unlikely that many new inventions will arise in the future, in terms of patent activity. This does not mean that the use of hydropower as a renewable energy source will not increase. On the contrary, it is expected to have a constant growth, particularly in developing countries.

Diversely, Micro Hydro systems have enough room for further technical developments. It is therefore likely that future patent protection and licensing arise under the small hydro dam

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[55] JOHANSSON, THOMAS B; MCCORMICK, KES;NEIJ, LENA and TURKENBURG, WIM C. *in: The Potentials of Renewable Energy,* A Global Review of Technologies, Policies and Markets, Edited by Dirk Abmann, Ulrich Laumanns and Dieter Uh, Earthscan, , United States, 2006, p. 29.

[56] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 11-14.

[57] Wikipedia website, available at : http://en.wikipedia.org/wiki/Renewable_energy, p. 5.

[58] Information available in the website: http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MjkwNjU.

technologies. As a consequence, the costs of these projects tend to decrease substantially with the technology improvement, and thus influence the prices of patent royalty negotiations.

The Damless hydro system is an even more promising technology, because it has less environmental effects of floods as the other hydropower alternatives. Projects for damless hydro power are under construction. Hence new inventions will be probably patented, especially in developed countries, and will be able to further negotiations to the exchange of technologies with less technologically advanced countries.

Concerning the OTEC technology, a research in the WIPO patent database of international patents registered under the Patent Cooperation Treaty ("PCT") accounts for the existence of 12 patent records (registrations and applications) related to OTEC[59]. Such number is not so expressive, because of the complexity and high costs for the development of the system. Due to these facts, the OTEC seems to be not as promising as the other ocean power sources of energy. It is unlikely that many countries have access and possibility to implement such technology, unless - eventually - the wealthier nations. As a consequence, the licensing of IPRs or transfer of OTEC technology are also unlikely to flourish, or will be attached to very high royalty prices.

The Tidal power is a technology still under improvement, therefore with promising field for IP protection and future negotiations. Researchers are analyzing the creation of new larger oscillating Tidal Stream water columns, in order to substitute the existent technology. The Tidal power has currently 61 patents records under the WIPO database, while Tidal Stream has only 2 records, as it is a very recent technology[60].

On the other hand, the Wave power has a volume patent activity of 57 records under the PCT database of WIPO, among registrations and applications[61]. This figure demonstrates the high potential of innovation and future IPRs issues of such renewable energy source.

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[59] WIPO patent database, available at the website: http://www.wipo.int/pctdb/en/.

[60] WIPO patent database, available at the website: http://www.wipo.int/pctdb/en/.

[61] WIPO patent database, available at the website: http://www.wipo.int/pctdb/en/.

Other technologies under development that are not yet commercialized should be also taken into consideration as potential future patent and utility model registrations, as well as licensing of rights of technology transfer. The Blue energy and Tidal Stream Power, for example, which are still under research, may be potential candidates of new IP rights and negotiations in the future.

3.2.5. Geothermal

3.2.5.1. Overview

Geothermal energy can be defined as the heat that comes from the core of the Earth. Its potential for satisfying the world's growing energy demand is enormous. The estimation of amount of geothermal heat in the outer 10km of the earth's crust has been calculated to be more than 2000 times the heat output of the total coal resources in the world. Scientists have affirmed that if some mean could be found to reduce the temperature of the earth's core by 0.6°C, there could be sufficient energy generation to power all the existing power plants for 20 million years.

Geothermal power plants use hydrothermal resources, which are composed with 2 ingredients: water (hydro) and heat (thermal). Geothermal technology requires high temperature (300 to 700 degrees Fahrenheit) of hydrothermal resources that may come from either dry steam wells or hot water wells. These resources are used by drilling wells into the earth and piping the steam or hot water to the surface. Geothermal wells have the height of 1 to 2 miles deep.

The power plants are divided into 3 different technologies:

(i) Dry steam plants are the ones that use steam piped directly from a geothermal reservoir to turn the generator turbines. The first geothermal power plant was built in 1904 in Tuscany, Italy at a place where natural steam was erupting from the earth.

(ii) Flash steam plants take high-pressure hot water from deep inside the earth and convert it to steam to drive the generator turbines. When the steam cools, it condenses to water and is injected back into the ground to be used over and over again. Most geothermal power plants are flash plants.

(iii) Binary power plants transfer the heat from geothermal hot water to another liquid. The heat causes the second liquid to turn to steam which is used to drive a generator turbine.

The costs of building a power geothermal energy station are high, but once the plant already exists, the operational costs are low for suitable sites. It is considered a sustainable energy source, because the hot water used in the geothermal process can be re-injected into the ground to produce more steam. Moreover, the environmental impacts from such facilities are minimal.

Geothermal is actually a mature technology, since is already being commercially used in over 70 countries. New plants are currently under construction in other 11 countries. The world's largest geothermal station installation is *The Geysers*, located in California, US, with a rated capacity of 750 MW[62].

Geothermal power stations can generate 2 types of energy, depending on the site and technology used: space heating or electricity generation. There are some areas of the world that are endowed with substantial reserves of hot groundwater. In these places, the geothermal plants may generate a variety of end-uses, such as space heating and cooling, industrial use, fish farming and health spas. Nevertheless, electricity is not generated by these plants, as no steam is released. This type of plant exists in Iceland and Australia. In some other areas of geological instability and volcanic activity, the hot underground water can be tapped and brought to the surface, becoming steam. Such steam is used to generate electricity, through the use of turbines that spins a generator. These plants are found in Italy, US, New Zealand, Philippines and Iceland.

Beyond the geological nature of the site, the technology used is also important. There are recent developments in the application of ground source heat pumps using the Earth as a source for heating and the heat sink as a source for cooking, depending on the season. This

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[62] WIPO patent database, available at the website: http://www.wipo.int/pctdb/en/.

technology of pumps can be used basically everywhere. It can be found, for instance, in Switzerland and in the US.

Recent researches are focused now on the potential to generate geothermal energy from hot dry rocks. By injection of cold water into the earth through drilled holes, the water becomes super heated in contact with underground heated rock, and is then discharged at the surface in the form of steam. This technology is still at experimental stage in Australia, but seems to be very promising[63].

3.2.5.2. IP issues regarding Geothermal

Geothermal basic technology is considered mature if compared to the other renewable energy sources. The WIPO patent database has approximately 130 patent records related to geothermal energy so far[64]. Nevertheless, the investments and researches for new technologies and improvements are continually growing, therefore new patents or utility models are expected to be registered in the geothermal industry.

Beyond the geological nature of the site, the technology used is also important. There are recent developments in the application of ground source heat pumps using the Earth as a source for heating and heat sink as a source for cooking, depending on the season. The technology for application of ground source heat pumps using the Earth of pumps is an example of patented invention.

Additionally, the recent researches on the potential to generate geothermal energy from hot dry rocks seem to be very promising. When such technology is ready to the commercialization, it will be subject to IP protection as well, and further negotiations on IPRs, licensing and technology transfer.

Since the new technologies and creations on geothermal energy derive mostly from developed countries, there is an expectation of future IPR licensing activity and transfer of technology to developing countries in a short run future. Europe and Australia, for example, are exploiting a

[63] LYSTER, ROSEMARY and BRADBROOK, ADRIAN J. *in: Energy Law and the Environment,* Cambridge University Press, Port Melbourne, VIC, Australia, 2006, p. 21.

[64] WIPO patent database, available at the website: http://www.wipo.int/pctdb/en/.

technology to create geothermal reservoirs in areas that lack either the water or the permeability, or both[65]. The US are developing new geothermal power systems that instead of using electricity to turn a heat pump to cool the liquid, runs a warmed liquid through a heat pump to generate electricity[66], and so on.

4. INTELLECTUAL PROPERTY AND RENEWABLE ENERGY

4.1. Is Intellectual Property Law an incentive or a barrier to the development and access to Renewable Energy?

4.1.1. IP Definition

Intellectual Property means basically the legal rights that result from intellectual activity in the literary, scientific, artistic or industrial fields. It is divided into three categories: (i*) Industrial Property*, i.e. patents (including utility models); trademarks; industrial designs; geographical indications and layout-designs of integrated circuits; (ii) *Undisclosed Information* (trade secrets)[67]; and (iii) *Copyrights*, which relates to literary and artistic works, as well as the rights of performing artists, producers of phonograms and broadcasting organizations.

In the area of renewable energy, the most important IP concerns are focused on Industrial Property (especially patents and utility model rights) and Undisclosed Information. Trademarks are sometimes attached to new inventions, and may occasionally be implied in the know-how that can be transferred together with the whole technology. Nevertheless, the second category of IP, Copyrights, will not be subject to specific study in this paper.

The Intellectual Property Law ("IPL") aims at safeguarding creators and other producers of intellectual goods and services by granting them certain time-limited rights to control the use made of those productions. IPRs, therefore, consist in a possibility of recoup of investments held in the Research and Development ("R&D") stage, during a period when the product

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65 Information available at the website: http://seekingalpha.com/article/25373-new-report-finds-potential-in-new-geothermal-technology.

66 Information available at the website: http://peswiki.com/index.php/Directory:Raser_Technologies_-_Geothermal_and_Waste_Heat_Harvesting.

67 COTTIER, THOMAS *in: The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs)*, The World Trade Organization: Legal, Economic and Political Analysis, vol. I, P.F.J. Macroy, A.E. Appletion, M.G. Plummer eds., Springer 2005, p. 96-100.

may be sold exclusively by the inventor. After this limited-period, the invention goes to the public domain, and will be certainly produced by other competitors, reducing its market price.

IPRs do not apply to the physical object, but instead to the intellectual inventions, comprising new solutions to technical problems. Innovative inventions can be protected by patents. The developments and actualizations of existing inventions can be registered as utility models, linked to registered patents. On the other side, industrial designs are aesthetic creations determining the appearance of industrial products. Furthermore, Industrial Property also includes trademarks, service marks, commercial names and designations, including indications of source and appellations of origin, and protection against unfair competition.

The application, approval and registration of IPRs are usually made by independent entities in each country that has IPL and regulations. In the international sphere, World Intellectual Property Organization ("WIPO") is the organism responsible for international IPRs registrations.

4.1.2. Conflicting views on the importance of IPRs

Discussions concerning the importance of IPRs are not new. The Agenda 21, agreed at the Rio Earth Summit in 1992, already called for enhanced actions towards the access of ESTs to developing countries, through technology transfer, purchase and licenses of patents on commercial terms, but always undertaking measures to prevent the abuse of IPRs.

However, there has been a lot of controversy regarding the role of IP protection regime in fostering innovation, technology and industrial development of a country. It's a discussion involving mostly the patent system than the other forms of IPR. Patents are expected to encourage innovation in industry, as inventors will be rewarded by the monopoly of rights guaranteed by IPL. But at the same time, there is a fear that strong IPRs would indeed inhibit diffusion of knowledge or even the technological development of developing countries.

The critics of IPL systems usually hold that IPRs prevent developing countries from the access of cheaper and adequate technologies, since prices of patented products (that mostly come from developed countries) are higher. They also affirm that when economies in the poorest stage move up into a middle-income stage, they acquire greater abilities to imitate new technologies; therefore the imposition of minimum standards for patent protection would not contribute to increased growth in those countries. There would be also doubt on the role of IPRs as a determinant of innovative activities, according to the critics, since much of the R&D in developing countries is of an adaptive nature, whereas weaker IPRs would stimulate more domestic innovative activities in poorer countries, and stronger IPRs would affect the innovative activity adversely, by chocking the absorption of knowledge spillovers which are important issues on innovative activity. In addition, the opponents of IPRs state that they would inhibit Foreign Direct Investments ("FDI") and trade[68].

It is true that the global technology innovative activity and production is mainly concentrated in the hands of technologically advanced countries, with just 10 countries accounting for as much as 84 per cent of global R&D activity. But some emerging countries are beginning to expand their patent registrations, as the example of Taiwan or South Korea. It is expected that the more the economies are becoming stronger, the more financial incentives for R&D are placed, and consequently the more inventions and FDI such countries will have. For this purpose, it is considered important that developing countries have their own IPLs, in order to permit the technology development that should follow.

With respect to the price of patented products, it is logical that the prices will be higher, which could be a negative obstacle for developing countries in the short run. But in the long run, however, even the least-developed countries could be benefited with IPRs protection. The IPL provides for alternative tools that might be adopted by developing countries, such as the voluntary or compulsory license, without prejudice to the transfer of technology programs. In the area of renewable energy, all these mechanisms are viewed as alternative solutions to overcome the barriers to technological access, since IPRs can also be utilized by countries as a wheel to push production forward.

In the long run, the IP regime will certainly affect the economic growth of the countries, by encouraging the innovative activity, which is the source of improvements on productivity.

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[68] KUMAR, NAGESH *in: Intellectual Property Rights, Technology and Economic Development: Experiences of Asian Countries,* Research and Information System for Developing Countries, Report commissioned by the IPR Commission as a background paper.

Stronger protection increases the revenue productivity and exportations, since counterfeiting will be more difficult, as it has been corroborated empirically by analytical studies. IP protection would be important to stimulate and reward innovation, which would enable the creation and further dissemination of advanced technologies. On the other hand, poor IPR regimes tend to affect adversely the international investments. Strong IPLs encourages the inflows of FDI, the technology transfer and international trade, which are factors that provide economic growth.

Other important aspect relates to the level of development of countries that might wish to implement IPRs. It is empirically demonstrated that the IPRs have played a positive role in the development of advanced economies. But concerning developing countries, it is clear that depending on the level of development of their economies, the positive aspects of IP protection can take a longer time to occur. The economies in higher stage of development may enjoy positive aspects of IPRs in a short run, while some developing countries or least-developed countries would just fell the advantages of IPL in the long run. This is because most of their industries still need to reach a degree of development already existing in other countries. Additionally their industries need to be constantly increased and developed, which is something that requires time and capital inflows. We are in the view that IPRs can be utilized – either by developing or developed countries - as a support mechanism to promote effective and dynamic competition, with appropriate transparent regulation. IPRs can play an effective role in enhancing technological change and growth[69], by creating the incentive structure needed for knowledge generation and diffusion, technology transfer and private investment flows.

Some studies on the importance of IPRs suggest that the effectiveness of patent protection varies from industry to industry, to the extent that the inventive activity can be more sensitive in some industries than others. The pharmaceutical industry, for example, is very sensitive to patent protection, since the monopoly rights often have a substantial upward impact on the price of products, as there are no or few substitutes for a new medicine in the market. Diversely, some renewable energy sources, as Hydroelectric and Geothermal, are being used for considerable time, thus most of the patent registrations have already expired, with exception of specific improvements and features that may still be registered as utility models.

[69] MASKUS, KEITH E. *in: International public goods and transfer of technology under a globalized intellectual property regime*, Cambridge University Press, Cambridge, 2005, p. 143-150.

Other sources of renewable energy are completely new and under research, such as the Tidal Stream Power and the Blue energy.

However, the competition between IP protected products in renewable energy market can be really greater than in the pharmaceutical industry, since different renewable energy sources may compete with each other, depending on the technological feasibility, which tends to brings prices down, if compared to the pharmaceutical industry monopoly prices[70].

On the other hand, one should not forget that renewable energy market is becoming each day more important with the worldwide effects of climate change and the need of substituting current forms of carbon energy. For this reason, renewable energy technologies are in constant renovation. New technologies are under development, which is a signal that the IPRs in renewable energy tend to perform a more important and active role with the time.

In the most recent COP held in Accra (August 2008), it was recognized that IPRs may eventually constitute a barrier to climate related technologies. It would depend on several issues, such as the particular technology - if it is patented or not; whether there are viable and cost effective substitutes or alternatives to the technology; the degree of market competition; the prices at which it is sold and the degree of reasonableness of terms for licensing etc. In case the IPRs are considered a barrier to renewable technology access, the COP listed a number of alternatives that the parties may adopt to "relax" the IPRs relatively to climate-friendly products and technologies, including (among others):

(i) A discretionary exclusion from patents in developing countries, by using the art. 27.2 TRIPs permission of exclusion from patentability inventions that are *"necessary to protect the ordre public or morality, including to protect human, animal or plant life or health or to avoid serious prejudice the environment";*

(ii) Compulsory licensing in developing countries, based on the TRIPs provision of Article 31, which confer the countries with significant flexibilities on the motivation of the measure;

[70] ICTSD – International Centre for Trade and Sustainable Development, *Links between Patent Rules and Access to Green Technology come under scrutiny*, Bridges – Weekly Trade News Digest, Vol. 11, Nr. 42, 05 December 2007.

(iii) Voluntary licenses to be held between developed and developing countries in a affordable and competitive manner;

(iv) Transfer of know-how and trade secrets, which would be held within a "global cooperation system" that should be a component of the technology transfer framework[71].

4.1.3. WIPO

The WIPO is one of the specialized agencies of the UN system of organizations that is responsible for the registration activities (including international patent registrations), promotion of intergovernmental cooperation in the administration of IP, and substantive or program activities. These activities serve the overall objectives of WIPO, which are to maintain and increase the respect for IP throughout the world, in order to promote industrial and cultural development by stimulating creative activity and facilitating the transfer of technology, as well as the dissemination of literary and artistic works.

WIPO's functional tasks are basically: assisting governments and organizations to develop policies, structures and skills on IP; the development of an international IPL[72]; administrating international IP related treaties; providing for a forum for informed debate and exchange of expertise in IP and finally administrating an international registration system for patents, trademarks, industrial designs and appellations of origin. The WIPO is considered one of the few global institutions that administer private rights[73].

As a consequence of the diverging views and perceptions among countries on the role of IP in their economic development, WIPO has not yet succeeded in implementing substantive standards with respect to IPRs. The harmonization of IP international protection is one of WIPO's functional challenges.

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71 THIRD WORLD NETWORK (TWN), *Possible Elements of an Enhanced Institutional Architecture for Cooperation on Technology Development and Transfer under the UNCCC*, Briefing Paper 3, Climate Change Talks, Accra, 21-27 August 2008.

72 GURRY, FRANCIS; ABBOT, FREDERICK M., and COTTIER, THOMAS *in: The International Intellectual Property System: Commentary and Materials*, Kluwer Law International, 1999.

73 WIPO – World Intellectual Property Organization, *An Overview*, 2007 edition, available at the website: http://www.wipo.int/freepublications/en/general/1007/wipo_pub_1007.pdf, p. 3.

Moreover, WIPO does not have an effective IP dispute settlement system, even for procedural matters, such as the registration of IPRs[74]. But with the advent of the Trade-Related Aspects of Intellectual Property Rights ("TRIPs") in the World Trade Organization ("WTO") law, the WTO members start to bring IP cases related to international trade to the WTO dispute settlement system. This was the solution to the absence of a specific IP dispute settlement system and the lack of international standards on effective enforcement of IPRs[75].

4.1.4. TRIPs and the WTO dispute settlement system

The TRIPs Agreement is a component of the Marrakesh Agreement Establishing the WTO[76]. It sets out minimum standards of IPRs protection that the WTO members must observe and enforce[77]. The TRIPs Agreement has significantly reinforced the IP international system. It has become a center for the enforcement of its substantive and procedural standards on IPRs[78]. With the implementation of TRIPs, the IPRs are now subject to an effective international litigation forum. Within the WTO dispute settlement system, the WTO members have also the possibility to cross-retaliate other members that infringe their IPRs[79].

With respect to the environment area, the TRIPs Agreement does not provide expressly for a special treatment or flexibility to the access and transfer of renewable energy or other ESTs, as it does in the areas of public health and nutrition[80]. Due to this fact, the TRIPs Agreement

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[74] COTTIER, THOMAS *in: The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs)*, The World Trade Organization: Legal, Economic and Political Analysis, vol. I, P.F.J. Macroy, A.E. Appletion, M.G. Plummer eds., Springer 2005, p. 10-15.

[75] COTTIER, THOMAS AND OESCH, MATTHIAS *in : International Trade Regulation*, Staempli Publishers Ltd. Berne, 2005, p. 922-923, 928.

[76] The TRIPs is inserted in Annex 1C of the Marrakesh Agreement Establishing the World Trade Organization, 15 April 1994.

[77] MASKUS, KEITH E. and REICHMAN, JEROME H. *in: The Globalization of Private Knowledge Goods and the Privatization of Global Public Goods*, Cambridge University Press, 2004, Journal of International Economic Law 7(2), 279-320, p. 281.

[78] ABBOT, FREDERICK M., COTTIER, THOMAS and GURRY, FRANCIS *in: International Intellectual Property in an Integrated World Economy*, Aspen Publishers/Wolters Kluwer, New York, NY, 2007.

[79] COTTIER, THOMAS *in: The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs)*, The World Trade Organization: Legal, Economic and Political Analysis, vol. I, P.F.J. Macroy, A.E. Appletion, M.G. Plummer eds., Springer 2005, p. 3-6.

[80] Article 8.1 of TRIPs expressly mentions that members may take measures and regulations *"necessary to protect public health and nutrition"*. The Ministerial Conference of the WTO on Quatar, 14 November 2001, and the Decision on Implementation of Paragraph 6 of the Doha Declaration on the TRIPS Agreement and

is being subject to many critics, including attempts to push for the revision of such Agreement, especially to allow the compulsory licensing of environmentally-friendly technologies[81]. Some environmental activists even argue the necessity of a provision in the TRIPs in order to definitely exclude the IPRs for the ESTs[82].

However, we are in the view that public international law system already has sufficient mechanisms, as voluntary and compulsory licensing for ESTs, as well as transfer of technology. The TRIPs Agreement is a part of the WTO Agreement, and therefore the TRIPs provisions must be interpreted in accordance with the General Agreement on Tariffs and Trade ("GATT"), and all its Multilateral Trade Agreements. These trade agreements are also a part of public international law, and therefore should be interpreted together with the provisions of other international rules, and not in isolation[83]. A concern with environmental protection is even expressed in the preamble of WTO Agreement, emphasizing the pursuit to the "*optimal use of the world's resources in accordance with the objective of sustainable development, seeking both to protect and preserve the environment*".

In this context, the TRIPs Agreement provides for the possibility of countries to exclude from patentability the inventions that are necessary to protect human, animal or plant life or health, or to avoid serious prejudice to the environment (article 27.2). This is a flexible mechanism that can be used by countries in renewable energy, under the justification that the atmospheric pollution represents a grave and potentially irreversible treat to human society.

In parallel, compulsory licensing is also a viable mechanism allowed by TRIPs. Although environmental protection is not expressly mentioned, articles 30 and 31(b) have a general terminology to explain in which cases Members may use the exceptions to exclusive rights of a patent. The terms *"national emergency or other circumstances of extreme urgency"* do not

Public health, adopted by the WTO General Council on 30 August 2003 are important regulations to make effective use of compulsory licensing in the pharmaceutical sector under the TRIPs Agreement. ABBOT, FREDERICK M. *in: The WTO Medicines Decision: World Pharmaceutical Trade and Protection of Public Health,* The American Journal of International Law, Vol. 99:317.

[81] According to the Resolution adopted on 29 November 2007 by the European Parliament, which urges examination of the possibility of revision of the TRIPs Agreement in order to allow for the compulsory licensing of environmentally-friendly technologies under patent protection.

[82] This is what the Friends of the Earth (an Environmental NGO) advocates, according to CRONIN, DAVID *in: EU Parliament Urges Change in IP Rules for Environmental Technology,* Intellectual Property Watch, 29 November 2007, available at the website: http://www.ip-watch.org/weblog/index.php?p=851&print=1.

[83] PAUWELYN, J. *in: How to Win a WTO Dispute Based on non-WTO Law?* Questions of Jurisdiction and Merits, Journal of World Trade 37(6), p. 1000-1003.

exclude the possibility of environment or climate change being considered as national emergency for that purpose. In fact, these issues reflect a transnational or ultra-boundary emergency. In our understanding, such TRIPs provisions may justify the applicability of compulsory license by WTO members in specific cases of urgency for the use of ESTs, including renewable energy technologies. Therefore, there is no need to amend TRIPs for this purpose.

It is also useful to mention that in the WTO dispute settlement system the Panels are entitled to apply not just WTO law and TRIPs Agreement, as a part thereof, but also MEAs, such as the UNFCCC and Kyoto Protocol[84]. Whenever a trade dispute with environmental issues is brought before the WTO dispute settlement, the Panel shall consider the MEAs as applicable law to solve the dispute[85]. This understanding is based on the provisions of the Dispute Settlement Understanding ("DSU"), mainly articles 7.2 and 3.2. According to article 7.2, *"Panels shall address the relevant provisions in any covered agreement or agreements cited by the parties to the dispute"*. This implies that non-WTO rules on public international law, such as the UNFCCC and Kyoto Protocol shall be equally taken into consideration by the Panels to solve the disputes[86]. In parallel, Article 3.2 of the DSU states that the GATT covered agreements must be clarified *"in accordance with customary rules of interpretation of international law"*, as reflected in the Vienna Convention on the Law of Treaties ("VCLT"). The Art 31.3(c) of VCLT states that for the purpose of interpretation of a treaty any relevant rules of international law applicable in the relations between the parties shall be taken into account.

4.1.5. Domestic IPLs

The TRIPs agreement establishes a series of IPRs standards that WTO Members must implement in their domestic legislations. Such standards are a reflex from IP legislation and

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[84] COTTIER, THOMAS AND OESCH, MATTHIAS *in : International Trade Regulation,* Staempli Publishers Ltd. Berne, 2005, p. 143-144 e 517-520.

[85] Report of the WTO Appellate Body on *EC - Conditions for the Granting of Tariff Preferences to Developing Countries* (WT/DS246/AB/R), stating that to find out what is "development, financial [or] trade need", the Panel may use multilateral instruments adopted by international organizations as a standard.

[86] Report of the WTO Appellate Body on *US – Import Prohibition of Certain Shrimp and Shrimp Products* (WT/DS58/AB/R), para. 130, where reference was made to non-WTO law such as UNCLOS and CITES in order interpret WTO obligations of the parties.

patterns already existent in the developed countries and in some developing countries, but still lacking in many developing and least-developed countries. Those countries need to integrate the international IP standards accorded in TRIPs agreement into their national systems, in such a way as to maximize the benefits and minimize the social costs. This is because the implementation of TRIPs standards in a developing country domestic legislation is certainly a financially burdensome task. For this reason, these countries need to use and defend the flexibilities still residing in the TRIPs Agreement and try to match those flexibilities with their widely different innovation assets or other comparative advantages. It is also important that these countries pursue technical and knowledge cooperation of developed countries, in order to be able to acquire and implement the TRIPs standards in benefit of their industries.

The principal objective of an IPL for a country is to promote the creativity by rewarding the public and private "inventors", which invested hardly in R&D, with the economical benefits of a monopoly, in such a way as to promote competition and fair trading, which will contribute to economic and social development. The IPRs deliberately restrain trade in the short run, in order to elevate the level of competition later on[87]. The countries that retain weak IPRs standards tend to remain dependent on counterfeiting and imitation activities, which are actually unproductive, since there is no fair competition in these markets.

The IP protection will consequently increase the revenue productivity of enterprises and can even help their trade and exportations, since counterfeiting will be more difficult and expensive. Strong IPRs may also motivate FDI and transfer of advanced technologies, since foreign enterprises will feel more secure to invest in a market where their products will not be subject to counterfeiting or imitations, and in addition they may receive the fruits of their R&D with higher monopoly prices derived from IP protection.

As we have mentioned before, depending on the level of development of a country economy, the positive aspects of IP protection will only be enjoyed in longer terms than in other economies economically more advanced. This is because the industries of some developing and least-developed countries need more time and capital investments to reach a certain degree of development. The level of trade openness is also an issue that may influence the effects of stronger IPRs, according to empirical studies. Stronger IPRs combined with trade

[87] MASKUS, KEITH E. and REICHMAN, JEROME H. *in: The Globalization of Private Knowledge Goods and the Privatization of Global Public Goods*, Cambridge University Press, 2004, Journal of International Economic Law 7(2), 279-320, p. 317.

liberalization tend to increase economic growth. And these outcomes, associated with other factors, such as FDI, human capital accumulation, local skill endowments and public infrastructure, seem to bring a positive result in raising productivity and economic growth. [88]

Overall, we understand that the IPRs can be utilized by countries to promote effective and dynamic competition, by means of a transparent regulation. IPRs can be active tools for the enhancement of technological and economic growth[89], by providing incentives for knowledge generation and diffusion, technology transfer and private investment flows.

In the renewable energy market, the IPR protection for new inventions is one of the main incentives for firms to engage in new R&D programmes. This is because the R&D projects in renewable energy require expressive investments to maintain innumerous expenses, such as huge and complex infrastructure installations (ex. geothermal and hydroelectric power plants), newest generation of equipments (v.g. PV cells and windmills), ultra-specialized physicians, geologists, engineers etc. With all such expenses, it is natural that the inventors are rewarded with the temporary monopoly rights provided by IPRs, so that they can recoup their investments.

4.2. Licensing of IPRs related to Renewable Energy

4.2.1. Voluntary Licensing

Through a patent licensing agreement, the owner of a patent, utility model or industrial design (either registered or under application) grants to a third party the right to use such privilege, remaining with the ownership of those rights. The beneficiary of a voluntary license has therefore the right to perform actions covered by the exclusive IPRs, under authorization of the technology owner. The granting of such license includes the licensor's obligation to supply the whole non-patented technology related to the object of the patent, i.e. know-how, which is necessary for an adequate exploitation of the privilege.

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[88] MASKUS, KEITH E. *in: Intellectual Property Rights in the Global Economy*, Institute for International Economics, Washington DC, August 2000, p. 143-170.

[89] MASKUS, KEITH E. *in: International public goods and transfer of technology under a globalized intellectual property regime*, Cambridge University Press, Cambridge, 2005, p. 143-150.

The "inventor" or "owner" can exploit his IPRs in different ways. The first way is to sell or license his idea to a company technically able to manufacture and/or distribute the products in the proportion of the market scale. Alternatively, the patent owner can become a manufacturer himself or even contract the manufacturing from third companies and latter just distribute the products. We will focus this paper on the first alternative, regarding the voluntary licensing.

Usually, licensing of IPRs is held between a developed-country company (as the licensor) and a developing-country company (as the licensee). Especially with the liberalization of world trade, it is likely that the firms wish to export to developed countries, and for that reason they may need a license from a developed-country owner of patent rights, in order to use and commercialize the technology unless it can find a way to build a new technology that could compete with such patent. But certainly the licensing of existing technologies will be often much cheaper and faster than the re-engineering procedure.

Under the licensor's perspective, the licensing agreement can be a more affordable alternative, if compared to FDI, because it can enable the supply his products in a developing country market through the facilities of a local company, without the need to invest in its own facilities in such country. It can be the best way to get more market access, reduce operational overheads and create equity returns to stockholders.

Nevertheless, depending on the technology involved, FDI might be economically more favorable than licensing. This is the case of technologies that are changing very rapidly, in such a way that new licensors, with new core expertise are needed from time to time, as per example the computer and software industry. The relationship between the foreign supplier and the local manufacturer can be updated more easily by means of managerial negotiations within one company, than through the formalities of a contract revision between two companies. In other cases, the licensing will be a better solution, as when the licensee company holds special knowledge of the local environment, which reflects a comparative advantage. The licensee is therefore in a position to negotiate effectively an agreement which provides him the licenses and technologies he needs.

Regarding renewable energies, the pace of technology changing is usually not so accelerated as in the computer industry. Renewable energy projects require complex and costly investments in machinery and huge infrastructure installations, while the computer industry does not require much more than the existing infrastructure (computers, software equipments and technical personal to explore new ideas). Hence, changing from a traditional to a newer technology in renewable energy takes longer time. In addition, some renewable energy sources are already in the market for a considerable time, with the same main players. Therefore, investors can feel more secure to handle a contractual long-distance relationship in renewable energies in order to acquire and maintain market access in other territories. But of course this is a decision to be taken on a case-by-case basis, and requires a complex economic-financial analysis.

Without prejudice, the renewable energy technologies that were subject of our analysis in this paper, with the only exception of Hydroelectric, are under constant research for new developments and improvements. This doesn't mean that they have the same mutant characteristic as the software and computer industry, but it means that new inventions and IPRs are about to arise, and as a consequence the "inventors" or patent "owners" will be then endowed with an important tool, which is the IPR itself, and thus will be able to decide in which way they will permit the utilization of this new technology in other territories of the world, whether by FDI, licensing or selling the technology.

Furthermore, with the increasing demand that results from climate change problems and the need of overcoming fossil fuel dependency, the renewable energy industry is now requiring improved personal skills and specific technological capabilities (know-how), which is mostly available only in certain developed countries. Thus, companies are seeking for strategic alliances and licensing agreements to carry out the production. Many of them are facilitating cooperative research efforts and making successful research alliances. This demonstrates that science and technology are developing faster than the countries' territorial limits and industrial organizations themselves[90].

4.2.2. Compulsory Licensing

The compulsory license is a non-voluntary license authorized by a public authority, under certain circumstances, to a private or public company, which is endowed with the right to

[90] BARTON, JOHN H., Stanford School of Law *in: New Trends in Technology Transfer – Implications for National and International Policy,* ICTSD – International Centre for Trade and Sustainable Development, Programme on IPRs and Sustainable Development, Geneva, February 2007, p. 21-22.

perform actions covered by exclusive IPRs without the authorization or will of the owner of such rights.

The institute of compulsory license is not so new. It was created in 1883 by the Paris Convention of the International Union for the Protection of Industrial Property as a remedy against the non-working of a patent within a set period of time[91]. Article 5A(2) of the Convention allows the contracting countries to take legislative measures to provide for the granting of compulsory licenses in order to prevent the abuses that might result from the exclusive rights conferred by a patent.

But according to the Paris Convention, the compulsory license can only be adopted within certain limitations. A company that fails to work the patented invention may only be penalized by a compulsory license if there is a request filed by an interested party after 3 or 4 years of failure to work or insufficient working of the patent. However, such request may be refused by the competent authority if the patent owner gives legitimate reasons to justify his inaction. In the other hand, the forfeiture of a patent may not be provided for, except in cases where the granting of a compulsory license would not have been sufficient to prevent the abuse. In this case, the authority may institute the proceedings for forfeiture of a patent, but only after the expiration of two years from the granting of the first compulsory license.

Later on, the TRIPs Agreement also implemented the possibility of granting compulsory licenses between WTO members. Its Article 31, for the first time in public international law, strictly regulates the substantive and procedural conditions for the granting of compulsory licenses. First of all, there has to be a prior effort to seek a voluntary license from the patent holder, and a consequent failure to achieve this (except in case of national emergency, extreme urgency and public, non-commercial terms). The compulsory license will be then granted on its individual merits, and the patent holder has to be adequately remunerated[92], with the right for a judicial or other independent mechanism for appeal. The license will be always limited to the purpose for which it was initially granted, and it must be non-exclusive, non-assignable, and be issued "predominantly" for the supply of the domestic market.

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[91] MYTELKA, LYNN *in: Technology Transfer Issues in Environmental Goods and Services – An Illustrative Analysis of Sectors Relevant to Air-pollution and Renewable Energy*, ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, April 2007, p. 6-7.

[92] COTTIER, THOMAS *in: The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs)*, The World Trade Organization: Legal, Economic and Political Analysis, vol. I, P.F.J. Macroy, A.E. Appletion, M.G. Plummer eds., Springer 2005, p. 85-94.

Countries with manufacturing capacity may eventually be authorized to export a "non-predominant" part of the production. Countries may also be granted the compulsory license for the importation of certain product with the purpose of meeting its domestic needs[93].

But the motives upon which countries may legitimately implement compulsory licensing is an issue still very controversial. The TRIPs leaves for the discretion of the countries the analysis of motives to invoke the measure. To date, there have been no claims under the WTO dispute settlement on this controversial issue, although the WTO has explicitly recognized the right of States to use compulsory license in order to promote access to technology[94]. In the public health area, the measure is already being taken by developing countries[95]. The Ministerial Conference of the WTO on Quatar, 14 November 2001, and the Decision on Implementation of Paragraph 6 of the Doha Declaration on the TRIPS Agreement and Public health, adopted by the WTO General Council on 30 August 2003 are regulations to make effective use of compulsory licenses in the pharmaceutical sector under the TRIPs Agreement[96].

For renewable energy technologies, the possibility of issuance of compulsory license is even more controversial, since TRIPs did not mentioned expressly the environmental protection among the conditions listed in article 31. Nevertheless, it seems to us that countries may eventually adopt compulsory licensing in specific cases of urgency for the use of ESTs, such as climate change effects, atmosphere pollution and the need of overcoming fossil fuels dependency. Articles 30 and 31(b) use a general terminology and leave to the discretion of the Members the motives upon which they may use the exceptions to the IP exclusive rights and granting compulsory licenses. These provisions do not exclude the possibility of

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[93] ABBOT, FREDERICK M. *in: The WTO Medicines Decision: World Pharmaceutical Trade and Protection of Public Health,* The American Journal of International Law, Vol. 99:317, p. 319.

[94] *Declaration on the TRIPs Agreement and Public Health*, WT/MIN(01)/DEC/2, para. 5-6, November 20, 2001.

[95] Some examples of compulsory license granted for patented products the pharmaceutical sector:
(i) South Africa and Thailand have adopted compulsory license in the pharmaceutical sector for the treatment of HIV (MYTELKA, LYNN *in: Technology Transfer Issues in Environmental Goods and Services – An Illustrative Analysis of Sectors Relevant to Air-pollution and Renewable Energy,* ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, April 2007, p. 7);
(ii) Taiwan has issued a compulsory license for the production of a medicine for avian flu (ICTSD – International Centre for Trade and Sustainable Development, *Taiwan Issues Compulsory License for Tamiflu,* Bridges – Weekly Trade News Digest, Vol. 11, Nr. 41, 30 November 2005);
(iii) Brazil has granted compulsory license for a HIV medicament, which enabled its pharmaceutical industry is allowed to manufacture generic versions of the drug (ICTSD – International Centre for Trade and Sustainable Development, *Brazil Issues Compulsory License for Aids Drugs,* Bridges – Weekly Trade News Digest, Vol. 11, Nr. 16, 09 May 2007).

[96] ABBOT, FREDERICK M. *in: The WTO Medicines Decision: World Pharmaceutical Trade and Protection of Public Health,* The American Journal of International Law, Vol. 99:317, p. 317-320.

atmosphere pollution and climate change effects being considered as national emergency or extreme urgency cases.

Evidentially, in order to grant the compulsory license, the country should have an internal legislation addressing expressly the possibility of compulsory license in cases of national emergency, extreme urgency or public non-commercial use. Furthermore, the compulsory license provision could encompass renewable energy technologies if there is a specific provision, in law or regulation, including the environment protection as a national emergency situation. Some countries have already adopted such provision in their laws, as in the case of Brazil[97], but so far none of them have effectively granted a compulsory license for environmental purposes. In fact, more important than having an internal regulation on compulsory license to ESTs is to have effective judicial and administrative mechanisms for the enforceability of such provisions[98].

In the international arena, there have been some attempts for the revision of the TRIPs Agreement with respect to the compulsory licensing of environmentally-friend technologies. The EU adopted a Resolution on 29 November 2007, urging the revision of the TRIPs in order to allow for the compulsory licensing of ESTs under patent protection[99]. Brazil has officially presented the same requesting in UNFCCC conferences (Bangkok, in Bonn[100], and more recently in Accra)[101], expecting that such proposal will result in more clarification on compulsory license for ESTs until the last conference of this round of negotiations (in Copenhagen by the end of 2009).

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[97] The Brazilian Decree 3201 of 1999 provides for the motives that justify the compulsory license, including the protection of environment among them (article 2, paragraph 2). This Decree regulates the nation's IPL, the Law 9279 of 1996, particularly with respect to the compulsory license allowed by its article 71 (legal texts available at the website of the Brazilian Intellectual Property Institute - INPI: http://www.inpi.gov.br/menu-esquerdo/patente/pasta_legislacao).

[98] WIENER, JASON *in: Sharing Potential and the Potential for Sharing: Open Source Licensing as a Legal and Economic Modality for the Dissemination of Renewable Energy Technology,* Berkeley Electronic Press Berkeley Electronic Press, 2005, p. 25-27.

[99] CRONIN, DAVID *in: EU Parliament Urges Change in IP Rules for Environmental Technology,* Intellectual Property Watch, 29 November 2007, available at the website: http://www.ip-watch.org/weblog/index.php?p=851&print=1.

[100] Brazil in *Brazilian Views on Technology Transfer,* 3 June 2008, Workshop on Technology Transfer during UNFCCC Climate Change Talks, AWG-LCA, Bonn, Germany (Brazil's Technology Presentation).

[101] THIRD WORLD NETWORK (TWN), *Possible Elements of an Enhanced Institutional Architecture for Cooperation on Technology Development and Transfer under the UNCCC,* Briefing Paper 3, Climate Change Talks, Accra, 21-27 August 2008.

4.3. Transfer of Technology

The term “transfer of technology” or “technology transfer” is used here with the meaning of an arrangement or agreement for the transfer and acquisition of technological knowledge and techniques not covered by Industrial Property rights, to be applied in the production of goods in general. It is usually an international agreement carried out by private enterprises, but it can also be undertaken by governmental entities. The term “technology” herein encompasses know-how and trade secrets, as explained below.

There are some technical discoveries or information that provide a valuable commercial advantage for a company, but may lack the novelty or inventive step required to make them patentable. Furthermore, there are innovative achievements concerning the conduct of business, commerce etc, which are not considered inventions in the field of technology. This range of knowledge is called ‘know-how’. Know-how is not technically considered as a part of IPRs, since it comprises information that cannot be registered as a patent, in spite of having commercial value. Nevertheless, know-how usually integrates IPLs, because it is the knowledge necessary for industrial capacity, creation and maintenance of IPRs.

Trade secrets (or undisclosed information) are information kept secret by a company interested in gaining an advantage over its competitors. With the advent of TRIPs, trade secrets are now considered as part of IPRs, although some national regulations still limit the protection of undisclosed information to the prevention of unfair competition[102].

Differently than Industrial Property rights, know-how and trade secrets may be transferred in a definitive manner to the receptor of the technology, whereas the Industrial Property rights would be just subject to licensing (temporary rights over the production, commercialization and even exportation of the products object of the rights). In other words, in the end of a licensing agreement, the licensee company has to stop completely the use of the Industrial Property rights (patent, trademarks etc.), while in the transfer of technology agreement, the receptor remains with the technology acquired even after the termination of the agreement[103].

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[102] COTTIER, THOMAS *in: The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs)*, The World Trade Organization: Legal, Economic and Political Analysis, vol. I, P.F.J. Macroy, A.E. Appletion, M.G. Plummer eds., Springer 2005, p.

Basically, the transfer of technology is a matter of flow of knowledge from one person to another. It is a process that we experience through all our lives, either by education, scientific literature or direct human contact[104]. In many cases it is necessary the temporary dislocation of technicians from one company to another or one country to another, so that the know-how will be transferred by means of seminars or practical trainings. Hence, technical assistance agreements are usually integrated in or correlated to know-how agreements.

In practice, technology transfer agreements usually have some of the following provisions:

(i) the supply of all product or engineering process technical data, including the methodology of technological development used for obtaining them, which data are represented by the set of formulas and technical information, documents, drawings and industrial patterns of instructions on operations and other similar elements to allow the manufacture of the product;

(ii) the supply of data and information for the updating of the product or process;

(iii) the disclosure of trade secrets for industrial application and consequent confidentiality obligation.

The stages of technology transfer are: (i) identification of needs; (ii) choice of the technology; (iii) assessment of transfer conditions; (iv) negotiation of the agreement; (v) adjustments and implementation; and finally (vi) transfer of technology. Other important issues to be taken into account in this process are the eventual barriers to the transfer of technology, such as the lack of information; lack of capital, high transaction costs; insufficient human capabilities, trade barriers; different policies; risk aversion; weak IPRs and enforcement of rights[105].

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[103] WIPO – World Intellectual Property Organization, *Successful Technology Licensing,* Geneva, September 2004, available at the website: www.wipo.org.

[104] BARTON, JOHN H., Stanford School of Law *in: New Trends in Technology Transfer – Implications for National and International Policy,* ICTSD – International Centre for Trade and Sustainable Development, Programme on IPRs and Sustainable Development, Geneva, February 2007, p. 3.

[105] HUTCHISON, CAMERON *in: Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?* University of Ottawa – Law and Technology Journal 3:2, 517 (www.uoltj.ca), 2006, p. 520.

The technology transfer between countries can be carried out in different pathways, such as government assistance programs; direct purchasing of enterprises; licensing of IPRs; know-how transfer agreements; FDI and joint ventures. Developing countries may be benefited from technology transfer by receiving and acquiring know-how from developed nations, which is a process that, in the long run, tends to promote capacity building, modernization and industrial growth of their economies. On the other hand, developed nations may also benefit from the negotiation by acquiring market access, reducing operational overheads and providing equity returns their companies' stockholders.

4.3.1. Current Patterns of Technology Transfer related to Renewable Energy

In the context of climate change discussion, the term "technology transfer" has been defined as *"a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions*[106]*."* It is certainly broad the scope of technology transfer if we consider the number of entities that may be involved in the combat of climate change, and may consequently facilitate the transfer of environmentally-friendly technology worldwide. This includes public and private sector entities, as well as international governmental[107] and non-governmental organizations ("NGOs")[108].

There is an increasing activity of funding and investments being directed to the challenge of renewable energy technologies. The World Bank, for example, has created its Clean Technology Fund. Japan has announced its Cool Earth Partnership, and the US and United Kingdom, together with Japan, have proposed the creation of a $10 billion Clean Technology Fund *"to help developing countries to bridge the gap between dirty and clean energy"*. Multilateral development banks and individual donor countries all around the world are also supporting dissemination of technology as the solution of climate change problems.

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[106] HUTCHISON, CAMERON *in: Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?* University of Ottawa – Law and Technology Journal 3:2, 517 (www.uoltj.ca), 2006, citing the Intergovernmental Panel on Climate Change (Bert Metz et al., eds), *Methodological and Technological Issues in Technology Transfer, 2000,* http://www.grida.no/climate/ipcc/tectran/index.htm at p. 3 (IPCC, *Issues in Technology Transfer*).

[107] Examples of Environmental International Organizations: UNEP, UNCED, UNFCCC, IPCC, among others.

[108] Examples of Environmental International NGOs: CIEL (Center for International Environmental Law); WBCSD (World Business Council for Sustainable Development); WWF (World-Wide Fund for Nature); ICTSD; Biofuelwatch, among many others.

The private sector investments in renewable energy are also growing considerable over the past few years. In 2004, the private investments accounted for $30 billion dollars worldwide, and by 2007 this figure has increased for $117 billion dollars. From this total amount, only $55 billion dollars was actual asset financing, while the rest are investments in international public organizations, venture capital and private equity. Nevertheless, the IEA has emphasized the need of at least $ 22 trillion dollars of new investments in renewable energy between 2006 and 2030[109].

Much of the renewable energy technology is implemented in developing countries through some form of technology transfer from developed country companies. There are several forms of technology transfer: (i) the provision of products that incorporate the technology, as the example of ozone-layer-safe coolant compounds of PV panels for off-grid electrical energy supply; (ii) the license of capability to produce such products, as it happens in the PV or wind sectors; (iii) the support of developing country's companies researching and production capabilities; and (iv) mergers and acquisitions of companies, as in the example of the Indian company named Suzlon, that expanded it technology capacity by acquiring a German firm, Repower, in 2007, and also a Belgian wind turbine gearbox producer[110].

As we have mentioned before, there are some MEAs and international declarations that contain generalized obligations to the developed nations to cooperate through the transfer of ESTs, including renewable energy technologies. For example, Principle 9 of the Rio Declaration on Environment and Development states that the countries *"should cooperate (...) by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies."* In the same direction, Chapter 34 of Agenda 21 addresses the role of patent protection in the transfer of EST and innovation, by stating the need for patent protection as an incentive to innovators, and also highlighting the need of dissemination of these technologies into developing countries.

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[109] COSBEY, AARON; ELLIS, JENNIFER; MALIK, MAHNAZ AND MANN, HOWARD *in: Clean Energy Investment – Project Synthesis Report*, International Institute for Sustainable Development (IISD), July 2008, p. 3, 9, 65-66, 69-70.

[110] BARTON, JOHN H., Standford Law School *in: Intellectual Property and Access to Clean Energy Technologies in Developing Countries – An Analysis of Solar Photovoltaic, Biofuel and Wind Technologies*, ICTSD – International Centre for Trade and Sustainable Development, Programme on Trade and Environment, Geneva, December 2007, p. 3 and 17.

In the Climate Change context, the UNFCCC has worded provisions on technology transfer for ESTs, such as the Article 11 (financial mechanism) and Article 4.7. The Kyoto Protocol establishes that the parties should *"cooperate to the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries, including the formulation of policies and programmes for the effective transfer of environmentally sound technologies that are publicly owned or in the public domain and the creation of an enabling environment for the private sector, to promote and enhance the transfer of, and access to, environmentally sound technologies"* (article 10 (c)). The Protocol also states that the countries have to provide all financial resources needed to meet the implementation of certain commitments, including the technology transfer to developing countries (Article 11 2(b))[111].

For the first time in the UNFCCC history, the transfer of technology has become a key issue and has attracted an increasing amount of attention. It was incorporated in the Bali Action Plan commitments. Environmental negotiators are currently searching for solutions to give effect to the technology transfer obligations to which they have undertaken under the UNFCCC, Kyoto Protocol and Bali Action Plan[112].

In the most recent COP held in Accra (August 2008), it was proposed the establishment of an Institutional Architecture for Technology Development and Transfer, which would ensure the effective implementation of the Convention with respect to commitments relative to development, application, transfer and diffusion of ESTs, practices and processes to support the action on mitigation and adaptation of environmental technologies. The purposes of the enhanced action on technology development and transfer are: (i) to make technology accessible to developing countries at most affordable cost; and (ii) to assist developing countries in the development of their own technologies.

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[111] HUTCHISON, CAMERON *in: Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?* University of Ottawa – Law and Technology Journal 3:2, 517 (www.uoltj.ca), 2006, p. 521-525.

[112] COSBEY, AARON; ELLIS, JENNIFER; MALIK, MAHNAZ AND MANN, HOWARD *in: Clean Energy Investment – Project Synthesis Report*, International Institute for Sustainable Development (IISD), July 2008, p. 69.

In order to make more effective and operational the implementation of such purposes, the COP parties discussed many solutions, such as the establishment of a Subsidiary Body on Technology that would assist the COP in the assessment of efforts for the development, application, transfer and diffusion of technologies, practices and process. A Strategic Planning Committee was proposed to provide regular guidance on matter relating to the UNFCCC's actions on technology development and transfer, providing regular expert assistance on technology-related matter to the COP. Technical Panels would be formed by experts to cooperate on a sectoral and cross-sectoral basis, addressing issues related to the technology development and transfer in relevant sectors, and IP needs and cooperation, including policies and measures, economic and financial issues etc. Finally, a Multilateral Climate Technology Fund was proposed to be established, using the funds of institutions (subsidiary body, planning committee, technical panels) and would be guided by a Technology Plan of Action drafted to support developing countries in all states of technology cycle: research, development and transfer of technology[113].

4.3.2. Transfer of Technology in the CDM

Although technology transfer is not the direct objective of the CDM in Kyoto Protocol, the complex structure of the CDM can contribute to foster technology transfer by financing emission reduction projects through the use of technologies that are not currently available in the host countries (usually developing nations).

The CDM allows industrialized nations that have accepted emission reduction targets to develop or finance projects of reduction of GHG emissions in non-Annex I countries (CDM Projects), in exchange for emission reduction credits. In this context, if the technology used in a CDM Project is not available in the host country, it must be imported. Each CDM Project must be duly approved by the governmental authorities of the host country, and in the process of emitting such approval, the host country may include technology transfer in its requirements[114]. The developed country (or Annex I country) will then assist the host country

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[113] THIRD WORLD NETWORK (TWN), *Possible Elements of an Enhanced Institutional Architecture for Cooperation on Technology Development and Transfer under the UNCCC,* Briefing Paper 3, Climate Change Talks, Accra, 21-27 August 2008.

[114] SERES, STEPHEN *in: Analysis of Technology Transfer in CDM Projects,* Prepared by the UNFCCC, Registration & Issuance Unit, CDM/SDM, December 2007, p. 7.

entity in implementing the carbon reduction through the CDM Project, which will lead to the technology transfer[115].

As the number of CDM Projects tends to rise globally, it is possible to predict future improvements on the level of technology transfer that is taking place in current CDM Projects portfolio[116].

Such technology may consist of the so-called "hardware" elements, v.g. as machinery and equipment for the production process, and/or "software" elements, including know-how, personal skills and knowledge.

Consequently, a study estimated that 39% of the almost 2300 CDM Projects analyzed up to September 2007 have claimed for some kind of technology transfer, which accounted for about 64% of the annual emission reduction. This study concluded that technology transfer is more common for larger projects[117].

Most of the projects (56%) involve transfer of knowledge and operating skills – the "software" elements - not only the transfer of equipments, or "hardware" elements.

The propensity of countries to attract technology transfer is very heterogeneous, due to a number of factors that differs from country to country, including the criteria used for approval of CDM Projects and the import tariff rates for environmentally-friendly products and inputs. It is estimated, for example, that 59% of the CDM Projects in China involve technology transfer, while 40% in Brazil, and only 12% in India[118].

On the side of the countries that transfer the technology, over 70% of all the technology transferred in CDM Projects come from Japan, Germany, the US, Great Britain and France. Nevertheless, at least 10% of the technology transferred in CDM Projects is originated from

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[115] BARTON, JOHN H. *in: Patenting and Access to Clean Energy Technologies in Developing Countries,* WIPO – World Intellectual Property Magazine, February 2008, p. 4.

[116] CONINCK, H. C. DE; HAAKE, F. and VAN DER LINDER, N. H. *in: Technology Transfer in the Clean Development Mechanism,* Energy Research Centre of the Netherlands, January 2007.

[117] SERES, STEPHEN *in: Analysis of Technology Transfer in CDM Projects,* Prepared by the UNFCCC, Registration & Issuance Unit, CDM/SDM, December 2007, p. 20-22.

[118] GLACHANT, MATTHIEU *in: Clean Development Mechanism and Technology Transfer,* Ecole des mines de Paris, May 10th 2008, available in the website: http://www.energypolicyblog.com.

non-Annex I, or developing nations, such as Brazil, China, India, South Korea and Chinese Taipei, which accounts for 94% of all equipment transferred and 74% for all knowledge transferred from non-Annex I countries.

As regards to the renewable energy technologies, a specific analysis, concluded in December 2007, estimates the following approximate percentage of the industries whose CDM Projects have claimed for technology transfer so far[119]:

Type of technology	**Technology Transfer Claims as Percentage of**	
	Number of Projects	**Annual Emission Reductions**
Tidal	100%	100%
Energy efficiency households	60%	91%
Fossil fuel switch technology	36%	77%
Wind	57%	73%
Energy efficiency own generation	42%	62%
Energy distribution	20%	61%
Energy efficiency supply	50%	58%
Energy efficiency service	33%	50%
Energy efficiency industry	25%	45%
Biomass	25%	44%
Geothermal	50%	41%
Solar	57%	30%
Hydro	9%	9%

These above-mentioned percentages include basically 3 types of technology transfer, differently distributed for each kind of industry:

(i) equipment only (hardware);
(ii) knowledge only (software); and
(iii) both equipment and knowledge.

[119] SERES, STEPHEN *in: Analysis of Technology Transfer in CDM Projects,* Prepared by the UNFCCC, Registration & Issuance Unit, CDM/SDM, December 2007, p. 27.

4.4. Public Policy measures to stimulate the development and dissemination of renewable energies technologies

The public policies, whether in national or international level, have a very significant influence on the development of new technologies for renewable energy market, which will lead to the licensing of IPRs and technology transfer. Empirical studies in OECD countries describe a rapid growth in wind energy patent activity since the mid-1990s, due to the influence of public policies in these countries. The Solar power is also responsible for significant patent registrations in developed countries, followed by biomass and ocean energy power. Geothermal is the only renewable energy source that felt a decrease of patent application after the 1970s. Important changes in public policy framework in these countries are responsible for the increasing patent activity, such as: subsidies to encourage R&D programs; investment incentives (v.g risk guarantees, grants, low-interest loans); tax incentives (v.g. accelerated depreciation, exemptions, rebates) and price-support policies (v.g. preferential tariffs, guaranteed prices). Voluntary programs were also developed (v.g. guaranteed markets). Recently, some trade measures were implemented, such as quantitative restrictions and tradable certificates, in which the quantitative obligations are traded across generators[120].

For renewable energies to become more competitive, public policies need to correct the imperfections of the market, removing subsidies to non-renewables and providing funding for renewable energy projects. It is also important the creation market mechanisms to guarantee market share and fair prices[121]. Supportive policy framework and suitable market conditions is essential for the development of renewable energies, motivating patent activity and further transfer of renewable technologies worldwide.

Notwithstanding, developing countries may face more difficulties in adopting some of these public policies to foster renewable technologies in their countries, due to the lack of capital, weak IPLs and anti-trust legislation, poor industrial infrastructure and so on. Therefore, it is

[120] JOHNSTONE, NICK; HASCIC, IVAN and POPP, DAVID *in: Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts,* Working Paper 13760, National Bureau of Economic Research, Cambridge, January 2008.

[121] GUEYE, MOUSTAPHA KAMAL *in: Asia and the Pacific: Policies for a Sustainable Energy Transition,* Linking Trade, Climate Change and Energy, ICTSD – International Centre for Trade and Sustainable Development, Trade and Sustainable Energy, November 2006, p. 10.

essential the support of multilateral mechanisms and international actions, such as the Intergovernmental Panel on Climate Change ("IPCC") and the UNFCCC, whereby the countries are called to reinforce their cooperation towards the promotion of technology development and capacity building in developing countries.

In this context, the last UNFCCC conference held in Accra (August 2008) reaffirmed the need for enhanced action on technology development and transfer to support the action on mitigation and adaptation, in order to make technology accessible and affordable to developing countries and to assist them in the development of their own environmentally-friendly technologies. For instance, the parties discussed the establishment of a Subsidiary Body on Technology that would assist the COP in the assessment of efforts for the development, application, transfer and diffusion of technologies, practices and process. A Strategic Planning Committee was proposed to provide regular guidance on matter relating to the UNFCCC's actions on technology development and transfer, providing regular expert assistance on technology-related matter to the COP. Technical Panels would be formed by experts to cooperate on a sectoral and cross-sectoral basis, addressing issues related to the technology development and transfer in relevant sectors, and IP needs and cooperation, including policies and measures, economic and financial issues etc. Finally, a Multilateral Climate Technology Fund was proposed to be established, using the funds of institutions (subsidiary body, planning committee, technical panels) and would be guided by a Technology Plan of Action drafted to support developing countries in all states of technology cycle: research, development and transfer of technology.

The COP in Accra also listed a number of alternatives that the parties may adopt to minimize eventual IPRs barriers relatively to climate-friendly products and technologies, including: (i) the use of compulsory licensing by developing countries, based on the flexibilities of TRIPs provision (Articles 30 and 31); (ii) voluntary licenses to be negotiated in a affordable and competitive manner; and (iii) transfer of know-how and trade secrets, which would be held within a "global cooperation system" that should be a component of the technology transfer framework[122].

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[122] THIRD WORLD NETWORK (TWN), *Possible Elements of an Enhanced Institutional Architecture for Cooperation on Technology Development and Transfer under the UNCCC,* Briefing Paper 3, Climate Change Talks, Accra, 21-27 August 2008.

5. Conclusion and Solutions to the use of IPRs for the development and transfer of Renewable Energy technologies

The renewable energy market is becoming increasingly sophisticated and important nowadays with the worldwide effects of climate change and the need of substituting fossil fuels and the current forms of carbon-based energy. Renewable energy technologies are in constant renovation, and new technologies are under development. This is a signal that the role of IPRs in renewable energy tends to increase with the time, as inventions and innovations in this area will constantly arise.

The international IPL has alternative mechanisms, such as the voluntary or compulsory license and transfer of technology programs, which could be applied in favor of renewable energies. All these mechanisms may be possible solutions to the barriers to technological access, since IPRs can also be utilized as a wheel to push production forward and a support mechanism to promote effective and dynamic competition, which requires appropriate transparent regulations. IPL can play an important role in enhancing technological change and growth[123], since it creates the incentives necessary for knowledge generation and diffusion, technology transfer, FDI, and international trade of renewable energy products.

The transfer of technology has become a key issue area of attention in the UNFCCC. Environmental negotiators are currently searching for solutions to give effect to the technology transfer obligations to which they have undertaken under the UNFCCC, the Kyoto Protocol and Bali Action Plan[124]. In the recent COP held in Accra (August 2008), a number of alternatives were drafted as solution to the minimization of IPRs barriers to the development and dissemination of climate-friendly products and technologies, including, among others: (i) the use art. 27.2 TRIPs permission of exclusion from patentability inventions; (ii) compulsory licensing based on TRIPs art. 31 (iii) voluntary licensing and (iv) transfer of technology:

Overall, it is essential to continue moving towards the achievement of environmental goals to the reduction of climate change effects. Public policies should motivate the dissemination of

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[123] Maskus, Keith E. *in: International public goods and transfer of technology under a globalized intellectual property regime*, Cambridge University Press, Cambridge, 2005, p. 143-150.

[124] Cosbey, Aaron; Ellis, Jennifer; Malik, Mahnaz and Mann, Howard *in: Clean Energy Investment – Project Synthesis Report*, International Institute for Sustainable Development (IISD), July 2008, p. 69.

renewable energy technologies and investments (either public or private) in this sector, through the implementation of: subsidies programmes; tax and investment incentives; price-support policies; removal of trade barriers etc. For developing countries, it is also essential the support of multilateral mechanisms and international actions to reinforce the cooperation towards the promotion of technology development, transfer and stimulation of capacity building in those countries.

Other solutions have been mentioned recently in the environment sector, such as creation of a technology development fund to the needs of developing countries and assistance on research and industrial capacity building[125]. The proposal of a Multilateral Climate Technology Fund was put on the table in the last UNFCCC COP to support developing countries in all states of technology cycle: research, development and transfer of technology.

Developing countries, like Brazil and India, have also proposed the establishment of national/regional technology excellence centers to promote technology development, deployment and transfer in ESTs, stimulating capacity building, improving access to information through an appropriate international cooperation environment. Research development programmes would be jointly planned and coordinated by developed and developing countries. These solutions would make the future renewable energy technologies more accessible and affordable, especially to developing countries[126].

Overall, countries need to seek forms of breaking barriers and improving the domestic investment environment that will foster the development and transfer of environment-friendly technologies[127]. The implementation of the IP mechanisms presented in this paper, such as the issuance of compulsory licensing (TRIPs articles 30 and 31) and technology transfer, may be useful solutions to the dissemination of renewable energy technologies on a worldwide basis, in view of substituting the current forms of carbon energy and minimizing the global effects of climate change for the benefit of our future generations.

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[125] ICTSD – International Centre for Trade and Sustainable Development, *Links between Patent Rules and Access to Green Technology come under scrutiny,* Bridges – Weekly Trade News Digest, Vol. 11, Nr. 42, 05 December 2007, p. 3.

[126] THIRD WORLD NETWORK (TWN), *Possible Elements of an Enhanced Institutional Architecture for Cooperation on Technology Development and Transfer under the UNCCC,* Briefing Paper 3, Climate Change Talks, Accra, 21-27 August 2008.

[127] COSBEY, AARON; ELLIS, JENNIFER; MALIK, MAHNAZ AND MANN, HOWARD *in: Clean Energy Investment – Project Synthesis Report*, International Institute for Sustainable Development (IISD), July 2008, p.69.

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