# Landscape and Energy

**From planning to landscape integration of infrastructures for renewable energy production**

# Paisagem e Energia

Do ordenamento da paisagem à integração paisagística de infra-estruturas para produção de energias renováveis

Universidade de Évora
Dissertation – Master in Landscape Architecture

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**Resumo**

Esta dissertação é uma reflexão sobre os distúrbios climáticos devido à actividade humana e sua dependência histórica dos combustíveis fósseis para produzir energia. Chama a atenção para a necessidade do uso de energia renovável e que medidas podem ser tomadas para tal, respondendo a algumas questões neste contexto: que tipo de estruturas existem para produzir diferentes tipos de energia renovável? E no caso específico dos parques eólicos: que impactos podem ter na paisagem?

O objectivo da tese é identificar os critérios mais importantes a considerar no planeamento de áreas destinadas à instalação de parques eólicos.

Assumindo que a produção de energia renovável exige a instalação de estruturas, é importante uma análise cuidada no planeamento destas áreas. A tese não estabelece regras aplicáveis a todos os casos. Cada paisagem tem as suas próprias características e é percebida de forma diferente por cada pessoa.

**Palavras-chave**

Análise da Paisagem, Distúrbios Climáticos, Eficiência Energética no Planeamento, Energia Renovável, Espaço e Lugar, Recursos Naturais.

## Landscape and Energy

### From planning to landscape integration of infrastructures for renewable energy production


**Abstract**

The study is a reflection on the climate disturbances due to human activity and its historic dependence on fossil fuels to produce energy. It notes the need for the use of renewable energy and what steps can be taken for such, addressing some issues in this context: what kind of structures exists to produce different types of renewable energy? And in the specific case of wind farms: what impacts have in the landscape?

The aim of this thesis is to identify the most important criteria to consider when thinking about planning an area for a wind farm installation.

Assuming that the production of renewable energy requires the installation of structures, is important to care on the planning of these places. The thesis does not establish any formula that applies anywhere. Each landscape has its own characteristics and is perceived differently by the people.



**Keywords**

Climate Disturbances, Energy Efficiency in Planning, Landscape Analysis, Natural Resources, Renewable Energy, Space and Place.

**Preface**

The inspiration to work with structures for renewable energy production and their integration in the landscape came from the growing need for the use of so-called "clean energy" in the today's world. Comes with a very timely in that the majority of EU countries put much effort in order to implement practical policies and plans for development of renewable energy. This importance is twofold, first the contribution that renewables can play in our energy system and secondly, the positive effect they will have on reducing greenhouse gases.

My home country, Portugal is one of the European countries that has more favourable weather conditions for large-scale use of renewable energy. Being in Sweden to study, I became aware of another reality: Nordic countries invest a lot in energy efficiency and in renewable energy production. I found interesting to compare both scenarios and get the best of each.

Also the cases chosen for study have a special story. Still in Portugal, during a lecture in a course where we were talking about changes in the landscape, and how it can affect our lives, there was an example of a wind farm that would be built in a place where would make unfeasible the practice of paragliding, which until then took place there. It seemed a case quite relevant and interesting enough to study further. The first day I arrived in Sweden, and when I was crossing the bridge that links to Denmark, caught my attention the turbines in the background that appeared in the middle of the sea. It was the first time I saw a wind farm off-shore with my own eyes and I was really motivated to study this case thoroughly.

Inspired by this, and as a landscape architect, I wonder: What kind of structures exists to produce different types of renewable energy? And in the specific case of wind farms, what impacts have in the landscape? To get some idea about it, I believe it's important to understand the character of the place and at the same time reflect on what they are or could be the tools to not attack, or that the impact of landscape changes as small as possible.

This thesis does not attempt to say that the methods previously used for landscape analysis and location of structures are outdated and must be replaced. Rather, it is to analyze, ask questions, discuss, gain knowledge and reflect on what might help reduce the impact of these structures, combined with existing knowledge and experiences. The thesis does not define answers and solutions; I understand it as a discussion of how to address the changes and needs of the contemporary rural landscape.

Early in the work, I read a paragraph written by Dame Sylvia Crowe in 1958 and Cited in Inspiring Place Pty Ltd in 2002, which became an inspirational quote:

*"The balanced landscape which we need at this point in our evolution, is one in which the excitement and possibilities of the new machines may in certain areas be seen contrasted against the peaceful background of a landscape matured in the age-tested harmony of nature."* (Dame Sylvia Crowe, 1958)

Applying Sylvia Crowe's words, renewable energy structures (R.E.S.) are strong elements, symbol of new technologies and the production of renewable and sustainable electricity. Like the old windmills represented a technical development and had a huge impact on the landscape, becoming later a part of traditional landscapes.

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## 1-Introduction

Time and change are important dimensions of the landscape. Our interpretations of landscapes are partly based on these aspects. The past is considered in different ways in the landscape, and thus created a grid of time, space and functions. Legibility is the presence of structures of the past, and other functions, perhaps immaterial, remains in the landscape. Legibility often provides a sense of belonging and identity at local level. Change happens around the places that tend to be more persistent in its character, for example the prehistoric sites, churches, etc; they are nodes in the conceptualization of landscapes. Changes cannot (and should not) be interrupted landscape architects and planners can help change happen in a way that considers the past and the past of places in order to maintain roots, identity and history.

The world must find ways to progress without attacking. Many effects of development are excellent, however, the price to be paid cannot be the destruction of planet Earth.

*"Humanity today has the capacity to develop in a sustainable manner; however we must ensure the needs of the present without compromising the propensities of future generations to meet their own needs."*

*Written during the Agenda 21*

## 1.1-Climate disturbances the need for change

The increase of global temperature is attributed directly or indirectly to human behavior that modifies the global atmospheric composition, added to natural climate variability observed in similar periods of time due to a raise in atmospheric greenhouse gas concentration, resulting in many climatic shifts and impacts in the planet (UNFCCC 2009). There are many gases that are naturally in the atmosphere and contribute to the Earth's surface warming by trapping heat from the sun, also well-known as the greenhouse effect. However, burning fossil fuels and clearing forested land through burning or logging trees also contributes to the concentration of greenhouse gases (GWEC 2008). The impacts of climate changes can be an increase in global air and ocean temperatures, accelerated melting of sea ice, extensive retreat of glaciers, rising global average sea level, and extensive changes in weather patterns, including changes in precipitation levels and increased storm strength. In the increasing atmospheric concentration of carbon dioxide, oceans absorb more carbon, causing ocean waters to become acidic. This complicates the calcifying organisms such as corals and crustaceans to form hard shells or skeletons, affecting marine and eventually the entire food chain (UNFCCC 2009).

The climatic alterations are now accepted as the biggest environmental threat that the world faces and maintains a global temperature at sustainable levels, has become one of the main worries of the political deciders (GWEC 2008). Before the facts, several countries signed and ratified the United Nations Convention Board on Climate Alterations (adopted in 1992, came into effect in 1994) and the Kyoto Protocol (adopted in 1997, ratified in 2002 by the European Union, came into effect in 2005), these documents constitute the only international framing to fight against the climatic operations (APA 2009; UNFCCC 2009). The Protocol pretends to be a control instrument and gas emission reduction with a greenhouse effect, establishing legally binding limits for the emissions of the latter and making the developed countries responsible while producers (UN 1998). The energy sector represents the biggest source broadcaster of GHG, annually emitting 26 thousand million tones of CO2, which is equivalent to about 40% of the CO2 emissions (EWEA 2008; GWEC 2008). The effective reduction of these emissions in this sector goes through the increase of the energetic efficiency and conservation, substitution of coal for gas and adoption of the renewable energetic sources (GWEC 2008).

It is necessary to think about both vulnerability and sensitivity of populations for specific health outcomes to changes in temperature, rainfall, humidity, storminess, and so on. The increasing global concern with the problematic of the climatic changes, and consequent necessity of the reduction of the greenhouse gases emissions, is also related with the widespread depletion of the fossil fuel (HOEL & KVERNDOKK 1996). Following the growing energetic search, the fossil fuel prices are also increasing and these will be progressively more difficult to extract. The reserves are concentrated in a reduced number of localized countries, in general, in regions of high geopolitical instability (CE 2006; GWEC 2008; SHAFIEE & TOPAL 2009). With the increase of global search, chains of stretched supplies and a greater dependency of imports, it is expectable that the prices of fuel and gas will remain high and with a trend to increase (CE 2006).

Fossil fuels (fuel, coal and natural gas) are the main world energetic sources, and in view of the actual intensified decrease of these reserves, will require an increasing demand for alternative energies (SHAFIEE & TOPAL 2009). Consequently, and answering to the compliance of the aims established by the Kyoto Protocol, a growing development of the associated technologies to the production of energies through bio-fuels (GNANSOUNOU ET AL. 2009) or renewable energetic sources in general and of wind farm energy in particular, the latter being an energetic source with greater global growth rate (WWEA 2009).

The world economic security is deeply linked to the energy offer. The volatility of the fuel global market leads to uncertainty in the economy. The energetic security also refers to the capacity and reliability of the fuel refineries, power stations and electrical network. The big power stations are more vulnerable to ruptures due to extreme climate events, natural disasters and potential terrorist acts. The disperse production may provide a safer energy source and a more resistant electrical network. The transmission lines also need to be maintained and updated in order to deal with the growing search for electricity and new sources of energy.

With implementation of the Directive 2001/77/CE, the European Union acknowledges the necessity to promote the usage of alternative energy sources. This measure was reinforced in 2008, with the proposal of the Directive for the promotion of the use of energy from renewable sources. This document proposes, as an aim for 2020, a production of 20% of the total energy through renewable sources (CE 2008).

### 1.2-What steps can be taken

The world should adopt practices and technologies energetically efficient to answer the global energy demand, changing habits and behaviors of ordinary citizens - consumerism, transporting products over long distances instead of using local products as the example of the fruit throughout the year, since that almost no longer exists seasonal fruit.

Despite the global dependency on fossil fuels today, there are several options to begin the necessary transition from a harmful fossil fuel economy. There are also several alternative resources that can provide clean renewable energy to replace fossil fuels, such as water, biomass, wind, geothermal and solar. Each country has renewable resources that may be used to guarantee a safer energetic supply. Improving the energy efficiency of buildings, vehicles, industrial process, appliances and equipment is the most immediate and effective way to reduce energy consumption. Planning communities where people can safely and conveniently use public transport, walking or cycling instead of using private vehicles, it also reduces energy demand.

The transition to clean renewable energy resources that do not emit new greenhouse gases into the atmosphere is possible. And the change of attitude begins at responsible land management practices to sequester more carbon in plants and soils. A quick implementation of these solutions will mitigate the impacts of climate change in coming decades.

### 1.2-1.Challenge to our society and for future generations

There is an urgent necessity for consciousness, in the search for balance between development and environment, trying to find ways of allowing environment regeneration. The development, understood as a cycle of consumption/production demands the extraction of raw materials, but not more than Nature can replace. That behavior is self-destructive and incompatible with human civilization. As if that were not enough, the residues resulting from those industrial processes are harmful to our health and well-being and can lead to large environmental losses.

The United Nations Conference on the Environment and Development, met in Rio de Janeiro, from the 3rd to the 14th of June 1992, reaffirms the Declaration of the United Nations Conference on the Human Environment, adopted in Stockholm on the 16th of June 1972, and specifies the most important principles for the socio-economic development with environmental quality: *"answering to the environmental necessities and the development of the present and future generations…"*. This principle should be carried out in the whole network of energy production, especially the one deriving from the non-renewable sources, conditioned if one considers the constant growth of the world population. In this way, demographic policies become indispensable to adapt, of population control, economic and the decrease of social disparities, throughout the countries, as poverty makes up one of the main obstacles to the sustainable development (BARBIERI, 1997).

The simplistic vision of the energetic traditional planning only considered the comparative advantages of the costs of production and distribution, which would lead to an economic concentration in the production poles. In this model, the pretensions to contribute for the reduction of regional disparities are not met. The centralization of the energetic production implies a high cost in the distribution to the more and more disperse human establishments. The production of decentralized energy, as a way to generate employment and wealth, from the local potentialities make up an important mechanism to develop the regional economy. This way, the decentralization of the energy production arises as an option to the generalized loans nowadays, due to the lack of resources for great investments, to the concerns of environmental preservation and the necessity to supply electric energy to the population agglomerates further and further away from the energy production centers. The decentralized facilities for energy production are, in general, of a small and medium capacity, and make use of renewable energies (BAJAY and WALTER, 1989).

### 1.2-2.Energy efficiency

Energy efficiency is the percentage of total energy consumption of machinery or equipment that is consumed in useful work and not wasted as useless heat, simply means using less energy to perform the same task - that is, eliminate energy waste (PATTERSON 1999). Energy efficiency brings a variety of benefits: reduction of greenhouse gases emissions, reducing demand for energy imports, and reduce our costs at a household level and economy-wide level. Although renewable energy technologies also help achieve these objectives, improve energy efficiency is the cheapest - and often the most immediate - way to reduce fossil fuel use. There are enormous opportunities for efficiency improvements in every sector of the economy, whether it is buildings, industry, agriculture, energy generation or transportation.

Strategies to improve energy efficiency are primarily related to technology and design. However, the way people use these technologies will significantly impact its effectiveness. The motivation that families and businesses have to buy, install and/or activate a highly efficient technology; driving behavior; the amount of people who actually use public transportation when there is a cultural stigma against it. A large part of energy savings potential of technologies for high efficiency is lost due to social, cultural and economic variables. Building designers are looking to optimize the efficiency of construction and development of renewable energy technologies, which can lead to the creation of zero energy buildings. Changes in existing buildings can also be made to reduce energy use and costs. These may include small steps, such as choice of compact fluorescent lamps and energy efficient appliances, or larger efforts, such as upgrading insulation and air conditioning (RUANO 1999). The smart grid is another system that will improve the efficiency of power generation, distribution and consumption. It captures the "waste" heat from power plants and uses it to provide heating, cooling and / or hot water to nearby buildings and facilities. For vehicles using the technology already available or under development, the efficiency can be improved further with the commercial development of plug-in hybrids or full electric vehicles. About planning and community design, neighborhoods that are designed with mixed use developments and safe, accessible options for walking, biking, and public transportation are the key to reducing the need for personal vehicle travel.

### 1.2-3.Planning considering energy saving

Physical planning concerns the influence of public sector activities in land and resource use in a given space and at various scales. As such it is an important tool for controlling the use of natural resources. According to the European / Spatial Planning Charter (also called the Torremolinos Charter), *"Spatial planning is a geographical expression for the economic, social, cultural and ecological society. Is at once a scientific, administrative, technical and policy discipline evolved as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organization of space according to a global strategy."* The control of planning systems will depend on how some factors are addressed, such as the monitoring of projects, the responsibility for planning and the way of planning implementation.

Monitoring the projects - The legislation sets out general planning characteristics of the different plans. Legal guidelines regarding the actual content of a plan however vary from country to country and from plan to plan. National or regional plans are generally less specific than the detailed or local plans. Generally, control the content of the plan decreases as the plan becomes more comprehensive and vice versa. Besides the basic structure provided by the law of planning, the physical content of the plans can also be controlled through statutes or ordinances, or by other plans by issuing guidelines and directives of the authorities. Regardless of the model, it is imperative for the implementation process that the general objectives of planning are reflected in detailed plans (ANTHONY 1965). Although there were legal considerations of physical, provisions are vaguely formulated, and the cities are practically free to make their own interpretation. Strategic plans are a tool for development potentially very important. The large-scale planning and implementation has a positive effect on the objectives of planning the production of renewable energy.

Responsibility for planning - According to the obvious preference for a decentralized planning structure, the primary responsibility of planning is the responsibility of local planning authorities (ANTHONY 1965). The decentralization of local planning is natural, to develop projects within the municipalities, for example, residential areas, parks, roads, industry, etc., affecting especially the citizens of the municipality and is therefore normal that the planning decisions ultimately fall on people or their representatives (STEELE 2005). A system of decentralized planning, however, is not necessarily related to a municipal planning monopoly. While the provisions relating to resource management have an influence on planning a large scale, the cities are practically free to decide to implement the plan or not.

Planning Implementation - A major potential problem of having a highly decentralized system of planning is the question of implementation (STEELE 2005). The main issue here is to what extent the legal system has coercive measures to enforce the planning, in other words, what can be done during the development of plans. From the standpoint of the implementation of energy policy, it is certainly necessary that the system include a legal mechanism to challenge the inactivity. Normally, the State or any representative of the state has legal possibilities of planning and land if certain conditions are obvious, for example, if the municipality is passive or otherwise disregards national planning objectives (RUANO 1999).

Municipalities have a key role in fulfilling the commitments made before the European Union with regard to reducing emissions of greenhouse gases and the share of renewables in energy supply. Renewable energy is an integral part of Local Agenda 21 and is thus under the responsibility of municipalities. Local Agenda 21 reflects the concept of sustainable development into concrete actions and measures to be implemented locally (RUANO 1999). Therefore, it is expected that the implementation measures of Local Agenda 21 pass by a municipal action plan to promote renewable energy production. Energy policy should make reference to various actions with the aim of introducing the local dimension in energy management and utilization of resources, such as the programs/plans for energy and environmental impact of regional/municipal level, the projects of energy and environmental impact of municipal initiative, the promotion of energy efficiency measures and renewable energy in state and private buildings and the creation of the figure of "energy managers" at the municipal level or inter-municipal, through appropriate training programs.

Planning at this level is also the search for more favorable locations of buildings in climatic terms (mild situations in terms of sunshine, temperatures, winds, humidity, etc.) which reduces significantly the costs for heating/cooling to restore the comfort conditions. In addition to location, also the choice of materials, shapes and openings of buildings, as well as dealing with their surroundings have a strong influence on energy expenditure.

Renewable energy can bring benefits to local authorities and local communities, such as: creation of new jobs, reduced energy costs in the municipality, improving the competitiveness of local enterprises, reduce the energy bill of the poorest citizens, increased public participation in decision-making or increased security of supply of energy sources to the municipality. However, local resistance is rapidly multiplying. Regularly are reported initiatives taken by citizens protesting the decline in value of their land in the surrounding farms, against the noise of the blades to cut through the wind and also expressing dissatisfaction with the environmental impact.

### 1.2-4.Renewable energy and structures

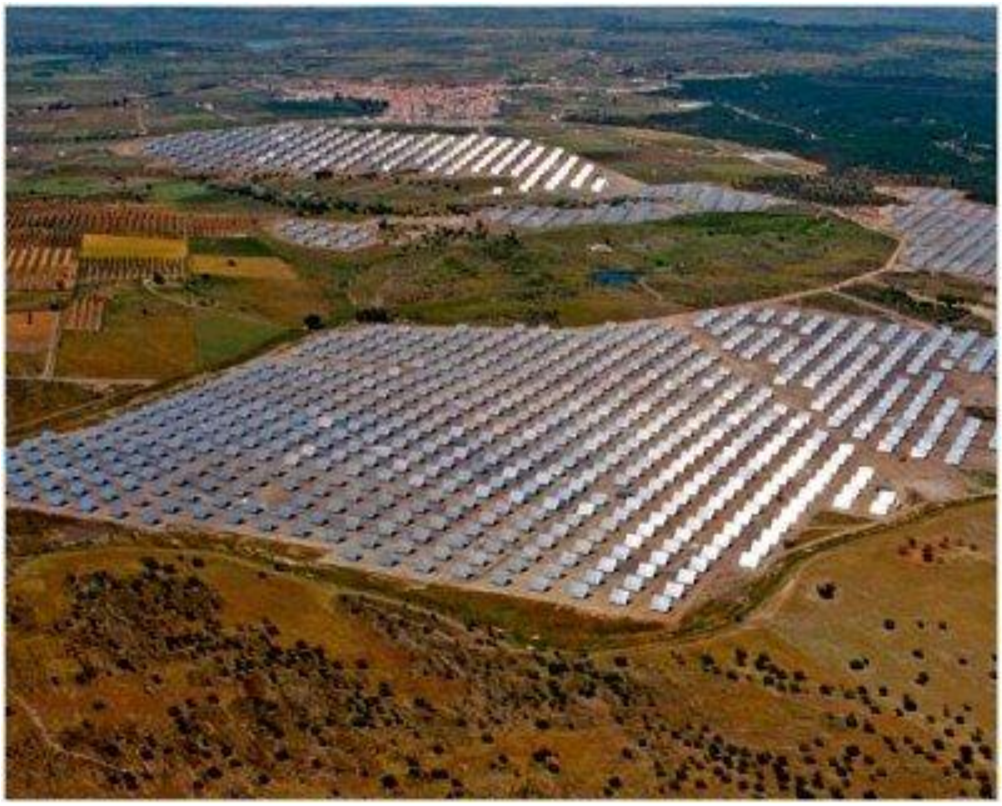
Renewable energy is natural energy which does not have a limited supply. Sources such as solar, wind, biomass, water and geothermal provide clean alternatives to the fossil fuels that cause climate change. Renewable energy has the largest impact on our environmental, security, and economic objectives when it is paired with aggressive energy efficiency strategies to reduce overall demand (CE 2006). Each type of renewable energy production includes various kinds of structures, which in turn are perceived differently by the public. This perception has a direct influence on the resulting impacts and public acceptance.

- Solar Energy

Solar radiation can be used directly as a source of thermal energy for heating fluids or spaces and to produce mechanical energy. It can also be converted directly into electricity, through effects on certain materials, especially the photovoltaic and thermoelectric. Almost all sources of energy - Hydropower, biomass, wind, fossil fuels - are indirect forms of solar energy. The efficiency of natural light and heat for space heating, known as passive solar heating, can be improved with the aid of architecture and construction techniques. The disadvantages of using solar energy are that one can only obtain it during the day and its storage is complex and costly (CE 2001). The structures used to produce thermal energy at low temperature are the solar collectors; at medium/high temperature are the solar troughs; and finally, to produce electrical energy are used photovoltaic panels (CE 2008) (Image I).

Image I

Photovoltaic Solar power plant in Moura, Portugal



Source: http://1.bp.blogspot.com (19-06-2011)

- Wind Energy

Wind energy is produced by the kinetic energy of air masses caused by uneven heating in the Earth's surface. Its production does not emit $CO_2$ or any other air pollutant. It is an abundant source of renewable energy, clean and easily available. With the aeronautical industry development, the equipment for wind power production has evolved, although it has some disadvantage of not being silent, change the landscape and affect some biological processes such as bird migrations (CE 2001). The structures used to produce mechanical energy are the traditional windmills and for electric power are the wind turbines (CE 2008) (Image II).

Image II
Wind farm in Havsnäs, Sweden

Source: http://www.rechargenews.com (19-06-2011)

- Biomass Energy

Biomass energy is obtained from renewable organic matter of vegetable or animal sources. Biomass is generated from agriculture, forest, and urban sources. It is used directly as fuel, representing the advantage that the gases produced by combustion of carbon have a lower proportion of sulfur compounds (which cause acid rain) than fossil fuels. Biomass is also used to obtain bio-fuel from digesters, which are accumulated organic debris, such as crop residues. However, biomass energy has disadvantages such as a low income, causes forest consumption to obtain wood to burn. The structures used for energy production by combustion are the traditional hollows, furnaces or boilers (CE 2008). For methane fermentation (biogas) are used anaerobic digesters (CE 2008) (Image III). For power production by pyrolysis (charcoal) are used as chambers of carbonization (CE 2008). There are also used aerators (CE 2008).

Image III
Anaerobic Digester plant in Sweden

Source: http://theenergycollective.com (19-09-2011)

- Hydropower and Other Water Technologies
    - Ocean thermal energy conversion (OTEC)

Uses the difference between the temperature on the ocean surface and a few meters down to provide the flow of heat needed to drive a thermodynamic cycle and produce other forms of energy (CE 2001). This technology is still under development and further studies must still be done on the environmental impact when pumping cold water to the surface (CE 2001).

- Energy from waves or tides

Electricity can be produced from the waves or tides movement due to the gravitational action of the Sun and the Moon. Coastal dams that generate electricity from the height difference between low tide and high tides were built in some places around the world. The disadvantage of this type of energy is that only a few places meet the requirements for dams, the high cost of such constructions, and changes in the rhythm of the tides, causes negative environmental impacts on estuaries and marshes. The structures used to produce electricity are the hydraulic turbines (CE 2008).

- Hydropower

Hydroelectric energy is obtained from the kinetic energy of water bodies from rivers, flowing from high altitudes to the sea through turbines. The disadvantage of this type of installation requires a large amount of water leading to the construction of dams, channeling and installation of large turbines and equipment. This requires a large investment and usually ecosystems are affected by the reservoir (Image IV) and the construction of dams. The structures used to produce electricity are the hydro turbines in dams (CE 2008).

Image IV
Reservoir of Alqueva, Portugal

Source: http://en.lifecooler.com (20-06-2011)

- Geothermal Energy

Geothermal energy comes from heat generated by the Earth's volcanic areas, geysers, cracks or basement rocks that are at high temperatures by the presence of magma chambers. To extract this energy requires the presence of water deposits near the location where the porous and impermeable rock layers hold water and steam at high temperatures and pressure, a phenomenon known as a geothermal reservoir. The exploitation of geothermal energy is accomplished by punching through the soil and extracting geothermal fluid (steam, water and other materials), which is used to obtain vapor and thus produce electricity from turbines. The production of geothermal energy has the advantage of being constant, since it does not depend on seasonal variations and is an ideal complement to the production of hydroelectricity (CE 2001). The structures used to produce high-enthalpy energy (electricity) are the steam turbines in plants (CE 2008) (Image V).

Image V
Geothermal power plant in Açores, Portugal

Source: http://geocrusoe.blogspot.com (20-09-2011)

**1.3-Landscape integration of energy production systems**

People have an emotional attachment to the landscape (RIGHTER 2002). In connection to this statement can be said about energy production systems in landscape that they are structures which guarantee reactions among people, raise discussions, meet various ways of perceptions, which could be detested, accepted or neglected. The question of this kind of alterations in the landscapes and people perception turned from former almost negligence to be more explored in recent years. This industry nowadays, needs to focus more on impacts and people.

Renewable energy landscape with its several attributes has been dogged by the criticism that it interferes with aesthetic and ecological values, that the surroundings have been changed and that the landscapes are being transformed into landscapes of power. But what is in focus is not a fuel such as coal with very dirty reputation, but an alternative energy resource with a benign image (PASQUALETTI 2002).

Energy structures are mostly perceived as visually objectionable, they presents objects cannot be climbed over or around, we cannot get inside, tinker with them and on many places even get close to them. Although the production of renewable energy is almost always well accepted, the location of the structures, in some cases, raises some concerns in the community as to its impact on the landscape.

The production of renewable energy involves certain impacts, which vary by the type of the explored energy and consequently the type of structure or technology used. Their perception is also different. Obviously a photovoltaic panel for solar energy production has other kind of impact that a wind turbine for the production of wind energy and their integration has to take into account different types of criteria. Given that Europe is, currently, the energetic revolution centre, leading the production and development of wind farm technology in global terms (TPWIND ADVISORY COUNCIL 2006; EWEA 2009a), this is the type of energy chosen for addressing the integration of structures for the production of renewable energy in the landscape during this study.

The wind turbines are different from the majority of the landscape alterations – the rotor blades – naturally attract attention. The rotors also cause some sound impact, which although may only be perceptible in a close perimeter to the turbines, may be the cause of dissatisfaction from some people as to its location (Image VI). The colour and the materials used in the design of the eolic turbines are characteristics that may also contribute so that the impact on the landscape may be less (Image VII). Also the constructions of the stations, access roads, electricity transport lines and other infrastructures that may be important in this field may represent an impact (Image VIII). As to the landscape impact of wind farms, one still has to refer the location (Image IX) and distribution of the turbines (Images X, XI and XII).

The alterations of the landscape that these structures presuppose, should respect a series of natural values, aesthetic, historic, social and crossed intrinsic with studies such as the sound and ecologic impact, which would allow people to know if the sound emitted by the turbines would disturb the nearest residences or if the sails would hit birds or bats during their normal course.

Image VI
Location of a turbine near a house

Source: http://www.elp.com (26-09-2011)

Image VII
Color gradient on a wind turbine

Source: http://www.windbyte.co.uk (26-09-2011)

Image VIII
Turbine access roads – Satellite view

Source: http://www.solaripedia.com (26-09-2011)

Image IX
Location of the turbines - offshore

Source: http://windy-future.info (26-09-2011)

Distribution of the turbines

Image X
Alignment

Source: http://www.solaripedia.com (26-09-2011)

Image XI
Dispersed

Source: http://www.wunderground.com (26-09-2011)

Image XII
Along the ridge

Source: http://knowledge.allianz.com (26-09-2011)

**1.3-1.Planning the integration of renewable energy structures (R.E.S.) – applied in the case of wind energy**

The wind farm energy produced in the last years has made it possible to avoid the annual emission of the equivalent to 24% of the European obligations towards the Kyoto Protocol (EWEA 2009c). In order to abide to the established objectives, it is necessary to reduce the costs as well as promote the integration of wind farm energy in the environment (EWEA 2009a). The production of wind energy is an important economic activity and the development of this technology is in progressive expansion.

Apart from the advantages related to the economic development, the production of wind energy also has social benefits with the creation thousand work posts. In addition, the resource to this type of energetic source presents diverse environmental advantages, when compared to fossil fuels, seeing that its production does not imply the emission of gases and is based in the usage of a renewable energy source (GWEC 2008). In this way, the wind farm production, when compared to the traditional energetic sources, does not present geopolitical risks, reduces the external energetic dependency, and independently on the fuel price as far as they do not present price oscillation, and unlimited and does not produce CO2, nor other harmful products like, for instance, radioactive residues (TPWIND ADVISORY COUNCIL 2006).

If on the one hand, the renewable energies in general, and the wind energy, in particular, produce few environmental impacts, and these are significantly lower than the ones produced by the conventional energies (GWEC 2008), on the other hand, this technology presents environmental impacts which magnitude and relevance depends on the location of the wind farm as well as the dimension of the turbines (BARRIOS 2004; BARCLAY ET AL. 2007). So as to maximize the energetic production, the wind farms should be situated in open areas and with high wind speeds, for that, the majority of these projects are located in high mountainous areas, coastal areas or offshore (DREWITT & LANGSTON 2006).

Related to the development of the technology of aero-generators, and in view to satisfying the growing energetic necessities, a progressive increase of their size and power has been verified (EWEA 2009a). It is now expectable that the future wind farms will have greater capacity installed resorting to a smaller number of aero-generators (TPWIND ADVISORY COUNCIL 2006). The progressive increase of the size of the aero-generators may mean the increase of the impact caused on the bird and bat population (BARCLAY ET AL. 2007), namely, the mortality due to direct collision, loss and habitat alteration, barrier effect and disturbance of the nidification areas (TRAVASSOS ET AL. 2005; DREWITT & LANGSTON 2006).

Apart from the direct impacts caused by the aero-generators, the indirect impacts as a result of the presence of the associated infra-structures, such as roads and electric lines, should also be evaluated.

Additionally the environmental impacts, the development of wind farm energy may also have negative impacts in the economic and social describers, depending on the extension of area used, possible tourism impacts, creation of territorial inequalities, visual impacts, noise production and the possibility of electromagnetic interferences (GAMBOA & MUNDA 2007; GWEC 2008). Although, generically, the public opinion is in favor of the wind farm energy and has an associated “green image” of it (EK 2005; GAMBOA & MUNDA 2007). Answering to the potential growth of this energetic source, of its application offshore and the development of the aero-generators, this fact may negatively influence the relationship among the communities and the authorities, the political decision process on the construction and location of a wind farm may be a source of conflict (GAMBOA & MUNDA 2007).

Generally the wind farms are made up by: one or more turbines; transport infrastructures such as the cables that link the turbines to the station and the transmission line to the electric net; access routes for construction and maintenance; and elements such as signs, fences among others. Usually, the variables to be taken into account in the wind farm projects are implantation and location, height of the towers/turbines, number of towers, blade movements, colour and materials and infrastructures (WFLV 2004).

The facilities for electric energy production are conceived and located so as to take advantage of the eolic resources available. On land, wind reaches its highest speed in open fields, ridge lines and coastal areas (WFLV 2004). The nearness to the existing electric energy infrastructures is also taken into account so as to minimize the costs of electric distribution generated, which makes it difficult to locate in remote or uninhabited areas. In this way, wind farms have a tendency to locate themselves in coastal zones, open areas in the interior, and ridge lines, where they are highly visible. These environments, especially the coastal situations, usually have a high cultural, patrimonial, environmental and esthetic quality.

The technologies for the construction of eolic turbines have developed a lot in the last years and are placed in very high places in order to reduce the friction with the topography, vegetation and built structures. Although there is technology for the construction of the higher turbines, the eolic turbines are about 120 meters formed by a tower of between 50 and 80 meters high and by the blades of the rotor up to a radius of 40 meters (WFLV 2004). The height of the individual turbines makes them potentially visible at a great distance, very often standing out in contrast in the landscape and gaining strength when seen with the sea or the sky as scenery. Another important fact is that turbines in group generate more electricity with less maintenance and distribution costs (WFLV 2004). However, as the individual turbines may become dominant elements due to their height, the groups of turbines have a potential impact and are highly visible as to the height combination, elements which are repeated and geographic area that it covers. Although the majority of the existing facilities have a few turbines, the trend nowadays, however, is that the wind farms may have more and bigger turbines.

## 1.3-2.Impacts in the values of the landscape

Although the physical characteristics and restrictions of the project relating to the potential impacts on the landscape of eolic energy installations may be easily documented, the way a wind farm affects the values of a landscape is not as easy to define. Thayer and Hansen (1989) recognize that there is a generalized acceptance of eolic energy though there is a high rate of the "not in my backyard" syndrome, especially related to the landscape invasion. However, modern wind farm researches in the United Kingdom have shown that the majority of the residents who live near these installations are in favor of the park, and that the real impact on the landscape was less than initially expected (COLLETT 1995).

The installations of wind farms have an inevitable impact on the landscape, though the design elements, scale and function contribute so that these impacts may also be positive. For many the shape, line and colour of the turbines is aesthetically pleasant. The design and appearance unit are positive aspects that in some cases may also improve the aspect of a degraded landscape (SMITH 2003). Windmills are strong elements, symbol of the new technologies and of the production of renewable and sustainable electricity. Like the old windmills represented a technical development and had a huge impact on the landscape, becoming later a part of traditional landscapes (Image XIII). Reflecting on the symbolic values, the positive aspect of the evolution of eolic energy is a result of its production, function and a public well-being using renewable means. Although a wind farm may have a prominent place in the landscape, convinces the public opinion more easily in detriment, for instance of the traditional extracting power stations.

Eolic turbines and its auxiliary structures (transmission lines of electric energy, stations and access roads for example) have an impact over the landscape character due mainly to its scale and dimension. The visual domain of the structures compromises the character of the place, contributing to an "industrialization" of the rural and natural landscape. Individually, the turbines may have a negative impact on the landscape, but it is as a set that the facilities have a greater worrying potential. Though it is not measured quantitatively, a greater number of turbines, covering a wider or more visible area, might probably be seen as unacceptable. A numerous set of small turbines has a greater impact than a minor set of turbines of a great dimension (VAN DE WARDT AND STAATS 1988).

Eolic generators are "easily seen with a clear sky" up to 20km, and Alan Wyatt suggests that apart from 5km "the impact is reduced to imperceptible". According to Inspring Place (2002a) an isolated turbine of a total of 120 meters high becomes imperceptible at 13,75km; however a set of turbines does not obey to this metric, depending on the proportion of the horizontal area they occupy.

Apart from being visually dominant elements in the landscape, the movement of the turbines may also produce other visual phenomena such as the reflex caused by the sun on the blades, blotting out and intermitting the shade. These effects tend to affect the proximity of the wind farms even though the sunshine is visible several kilometers away. Turbine farms may create significant changes in the perception of elements of the cultural patrimony and, therefore, an impact on the protection of its values. The landscape may also be identified as an item of significant patrimony, due to its association with history and culture. This value may be affected by a design or inadequate location of the eolic energy facilities.

Image XIII
Traditional wind mill landscape

Source: http://www.publicdomainpictures.net (26-09-2011)

### 1.3-3.How to minimize the impacts

It is for the planner to achieve a stable structure and evolution of the details so the landscape can be legible (LYNCH 1960). For the landscape can be read must have visual quality, and an enclosed structure so that one can identify points for the orientation, another key aspect. The image of a structure begins a process between the observer and the environment. The identity of a structure evolves from the practical significance or emotional that it has. The interaction among landscape elements involves strengthening or destroying the set of images that aid in the perception of the elements. Images can be distinguished according to their structural quality. The quality of the form may be present in different categories of direct interest in design and uniqueness, clarity of the picture, simplicity, continuity, control, differentiate directional, visual range, awareness of movement among others (LYNCH 1960). If there are changes in the landscape scale, as is the case of eolic turbines, the new scale requires a good organization and clarity, which causes the observer creates a "mental image" (LYNCH 1960).

In some cases preservation can be the only acceptable way to protect a value, for example in a place of high biologic importance. For other type of value, the impacts are more difficult to avoid. For instance, from a scenic point of view, it is virtually impossible to hide a wind farm (BIRKE-NEILSEN 1996). Vegetation as a curtain is only efficient when used between a point and a tower (SMITH 2003). In the same way, traditional treatments to minimize the visibility of development in the landscape, using topography, colours or reference textures in the surrounding landscape, are very difficult to reach, and concerning the turbines may even be undesirable (STANTON 1996). Instead of that, the careful disposition that avoids particularly sensitive characteristics, and highlights the positive attributes of the wind farms is a more efficient tool. Wulff (2002) points out that, of the possible actions for the eolic turbine planning: disguising or hiding, melting or integrating, or emphasize, the latter guarantees an easier result to get.

The height of the tower is much discussed - the turbines should not exceed the morphology of the landscape (INSPIRING PLACE 2002). The height of turbines is a project restriction, the bigger the rotor and the diameter of the rotor blades is, more electricity is produced. The wind speed varies with the location and proximity to obstacles, which will determine the height of the blades (Scheme I). In this way, a reduction in the height or diameter of the rotor may lead to a rise in the number of turbines proposed, which in turn may generate other undesirable effects, including visual pollution and a rise in the necessary area for the installation. Implanting a great amount of turbines in open fields, almost always results in bad public acceptance.

The number of turbines in grid may be more harmful than the height of the turbines themselves (VAN DE WARDT AND STAATS 1988). The impacts caused by groups of turbines may be reduced avoiding high density, which creates a certain visual confusion and grouping the turbines into “functional units”, with open spaces between them (GIPE, 2002). That can also be a useful technique to reduce the impact on the particular elements or characteristics.

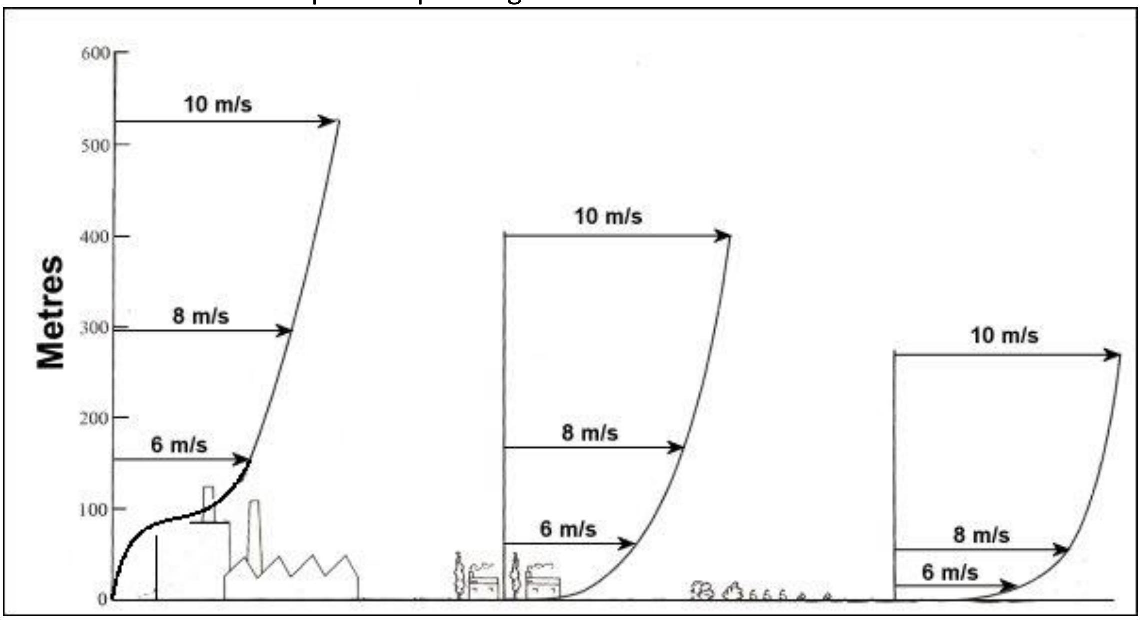
The disposition of the turbines in group reduces the visual threading but may also reduce turbine efficiency, which represents a challenge in the management of a wind farm (Scheme II). The implantation of the turbines according to the existing prominent characteristics, contribute to the legibility of a wind farm and, thus has a more positive and acceptable impact, for instance placing them along the ridge line in accidental topography or in grid on flat land. The implantation of towers far from the ridge line does not reduce the impact on the landscape and compromises the performance of the turbines (STANTON 1996).

The careful selection of colours and materials may reduce the contrast and visual impact of the turbines in the landscape. Soft colours (light grey, cream or brown) and the materials with an opaque finish may reduce the visibility and the contrast at a distance. However, if the surrounding landscape reference colours are used, it may also increase the contrast, if the sky is the background. Due to the scale of the eolic turbines, the majority of the views to the top of the towers and rotors have the sky as a background, and as such, light colours are recommended.

Highlighting the positive attributes as its aesthetics (using clean lines and modern materials) and function (all the turbines in movement) have been pointed out as important so as to guarantee a good public acceptance in the installations of wind farms (GIPE 2002; STANTON 1996).

The management of the negative attributes is also important, in spite of the difficulty in hiding the turbines, it is possible to hide or soften the potential negative characteristics of an wind farm, including the electric network (for instance, doing them in the park subsoil, thus avoiding visual conflicts with the turbines), roads (adequately placed so as to avoid sensitive areas and potentially subjected to great wear and tear) and disorder (cleaning the area and removing the residue) (GIPE 2002; STANTON 1996).

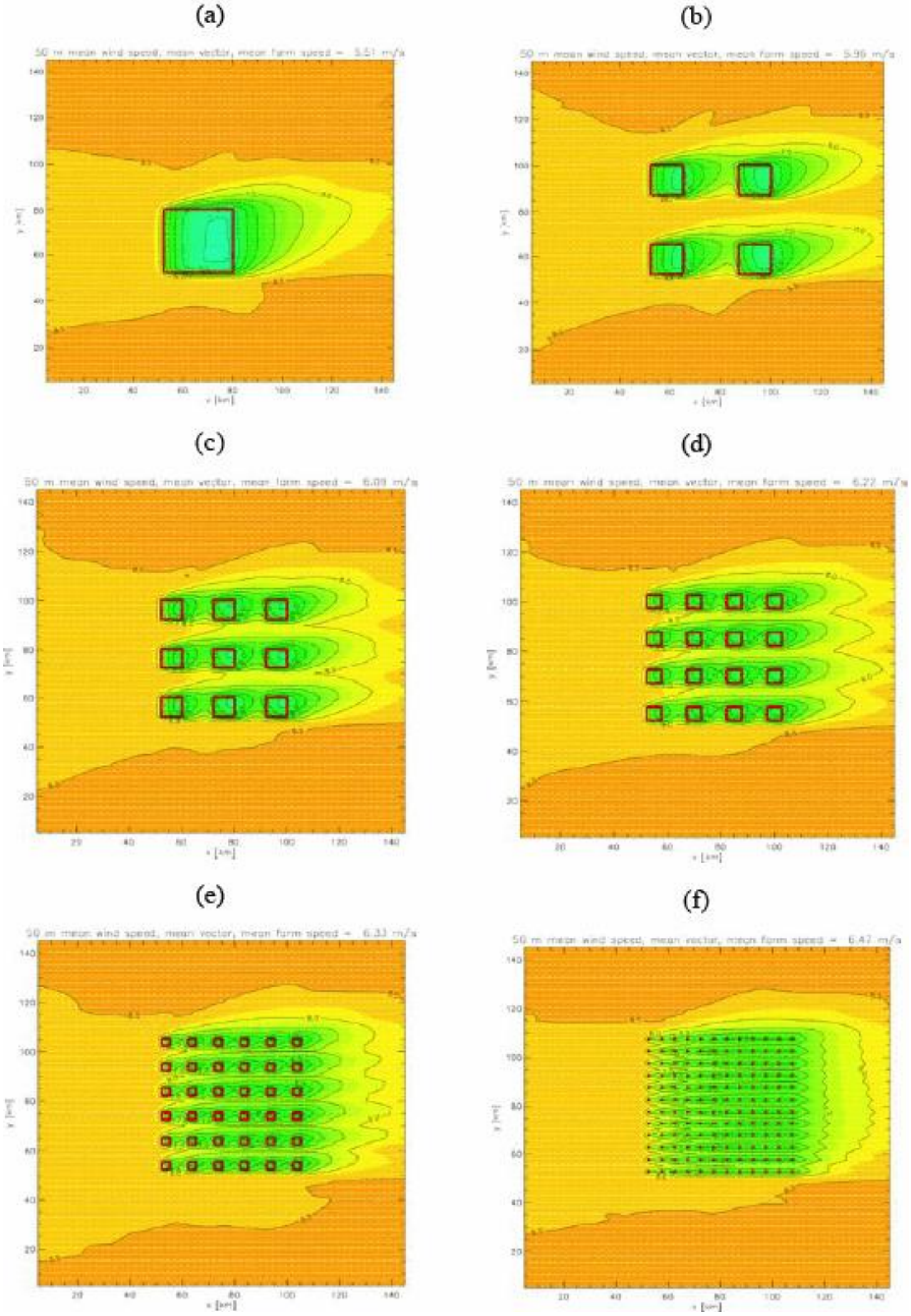
Scheme I
Wind speed depending on the location and obstacles




Source: http://www.wind-power-program.com (26-09-2011)

Scheme II

The disposition of the turbines in group related to turbine efficiency




Source: Summary report: The shadow effect of large wind farms: measurements, data analysis and modelling, Frandsen, Barthelmi, Rathmann, Jøgensen, Badger, Hansen, Ott, Rethore, Larsen & Jensen, Risø National Laboratory, Technical University of Denmark, Roskilde, Denmark, October 2007

# 2. Central Concepts

## 2.1- Space and Place

According to Yi-Fu Tuan landscape combines at least two different perceptions, thus creating a constant tension between the different meanings of the landscape. This tension stems from the fact that the landscape means both "domain" as "scenery". A domain in this context can be understood as a place, region, country or land inhabited by a people and therefore belongs to the political discourse, economy, politics and society. Scenery, by contrast, is part of the discourse of aesthetics and space. The meaning of the landscape is a subconscious interpolation of these two concepts.

In the book "The Phenomena of Place", Norberg-Schulz (1976) discusses the difference between space and place. He said the structure of local compromises both. So the space can be designated by nouns such as forest, street, square... But it may also be appointed by adverbs such as over, under, inside, outside... Finally he adds that the place is the beginning but is also the end.

Space is something that is socially produced, not as a physical arrangement of the elements. According to Lefebvre, space can be treated in three different ways: "Perceived Space," as in everyday social life, theoretical insight; "designed space," as the planners see it; and "living space" that is created through personal experience.

The space becomes something, when an activity takes place there. The significance of the place can be complemented with the Juaquim Español thought: one place is not just any place. It is a place with human remains. Thus, the physical space becomes a place through human presence (ESPAÑOL 2007).

Visual perception can give characteristic sense of space (TUAN 1974). To be aware of what kind of space is perceived, Tuan classified space into several dimensions depending on the distance and our senses. The first presents visual space dominated by the broad horizon and small, indistinct objects. It is the farthest removed and covering the largest area and even though things may move in it, people perceive this purely visual region static. But as Tuan writes, people normally don´t focus at this space, but on dimensions of proximate world which he describe as a visual-aural space with clearly visible objects where their noises are heard, characterized by feel of dynamism. Than there is the last dimension related to proximate space - affective space, zone next to our body, which is accessible also to the senses of smell and touch besides of sight and hearing.

Human beings are more sensitive to vertical and horizontal lines than to oblique ones (TUAN 1974). The vertical position stands for that which is instituted, erected and constructed and that it represents human aspirations. The vertical direction against gravity is feeling that lead to the inscription of regions in space to attached values expressed by high and low, rise and decline, climbing and falling and etc. They represent human aspirations that risk fall and collapse.

Related to strongly vertical character of Wind turbines and their rather sensitive issue Nielsen (2002) states: *“The vertical appearance of the wind turbine towers forms a contrast to the flat landscape, thus accentuating the horizontal aspect. Wind turbines located in a landscape already featuring vertical elements may result in a blurting effect. Where wind farms are located in flat and open landscapes, the retreating rows of wind turbines in a wind farm create perspectives that reveal the depth and distance of the landscape.”*

**2.2- European Landscape Convention**

The term or an idea of “Landscape” emerged in 15th and 16th century. At that time landscape presented a *way of seeing*, composition and structuring of the world and it was strongly a visual term. Then, Johnson, 1755 [1968], describes it whit a double meaning: 1 - region from the perspective of a country; 2 - an image, which represents an extension of space, with various objects in it. (COSGROVE 1985) Most of approaches to landscape still concern mainly the visible landscape and interpretation of the features in it. Cosgrove (1985) sees the landscape as a cultural image, a pictorial way of representing or symbolizing surrounding. Still can be found approaches where landscape has much broader meaning. For example Ingold (1993) doesn´t share Cosgrove´s view, in his way landscape is not “just” a picture in the imagination, but landscape becomes a part of us, just as we are a part of it. He says that it is almost like environment, where people dwell therein and inhabits its places.

Based on the European Landscape Convention, must be considered: The subjective perception of the landscape – *landscape as an idea*; Democracy aspect of the handling of landscape – *communication*; Integrated view on nature and culture – *demands cross - sectorial work*; Holistic view – all landscapes matters, even those that are thought of as ugly or everyday landscapes – *calls for overall landscape assessments*.

As can be found different approaches to landscape, can be also found many definitions of the same. According to the interest in wind power landscape it should be highlighted the one, which proceeds from European Landscape Convention. This convention can tell a lot about how European theorists perceive landscape in practice: *“landscape is an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors”* (Council of Europe, 2000).

According to Olwig (2009), landscape in the European Landscape Convention (ELC) presents more than just an area, view or panorama of natural scenery, but it also expresses the perceptions of an area that people share, value and use. In this way it is not just a given assemblage of physical objects, but rather a creation of changeable cultural perceptions and identities. Muir (1999) writes that in places which we experience we meet two closely related, but still different landscapes: the real landscape, lying beneath our feet and extending to the far horizon and the perceived landscape. Perceived landscape is based on sensed and remembered accounts and hypotheses about the real landscapes, it might be very close to reality, but it can also contain some important misconceptions.

Peter Howard said that this definition places the landscape almost in the category of intangible heritage. But the ways to conserve and preserve intangible heritage are specific and are about the information of the general population.

In the chapter "specific measures" the Convention states: "each party undertakes to promote awareness of civil society, private organizations and public entities about the value of the landscape, its role and its amendments." Every citizen has a portion of the landscape and the duty to care of it.

The practical implementation of the ELC will make the conflicts between different perceptions of the landscape decrease and thus facilitate the landscape planning.

## 2.3- Landscape Analysis

Landscape analysis is a tool used to identify and determine the character and the meaning of a landscape, and in case of a landscape disturbance, an impact on the character or meaning may be possible (WFLV 2004). In the case of structure installations for the production of renewable energy, the analysis of the landscape is an important mean of recognition of the characteristics and values of an area and surroundings, guaranteeing that the installation is sensitive to the potential impacts on landscape. However, there is usually a separation among cultural and natural, which notes the necessity of a holistic landscape analysis.

Many of the landscape characteristics and values are not easy to measure or quantify. It is possible to quantify the effects of the renewable energy installation in tangible values – native vegetation (if there is), but difficult to quantify the effects on the intangible values – the feelings of one individual on a place, for example. In any case, it is important to register and document the less quantifiable values, which represent a challenge for the planning and landscape analysis. Clearly, the information of the population in general promotes an effective participation of the community which is essential for this process.

The landscape characteristics that the renewable energy installations could potentially affect are several, such as the environment, (for example, the impact on animals or habitats), aesthetics (for instance a familiar connection with the landscape), emotional (for example, a feeling of admiration or loss) or cultural (for example, the impact on the characteristic of the historical or archeological importance). Thus, the landscape analysis requires an interdisciplinary approach in order to consider all the characteristics and values in a particular landscape.

Attributes like reduction in $CO_2$ emissions, renewable, clean etc. have been in focus when discussing attitudes to renewable energy on a national level, where most of people are very positive to renewable energy. Attributes like visual impact, noise, shadows, real-estate values, natural and cultural amenities, have been in focus when discussing attitudes to renewable energy on a local level, where many people are negative in connection to a specific development plan.

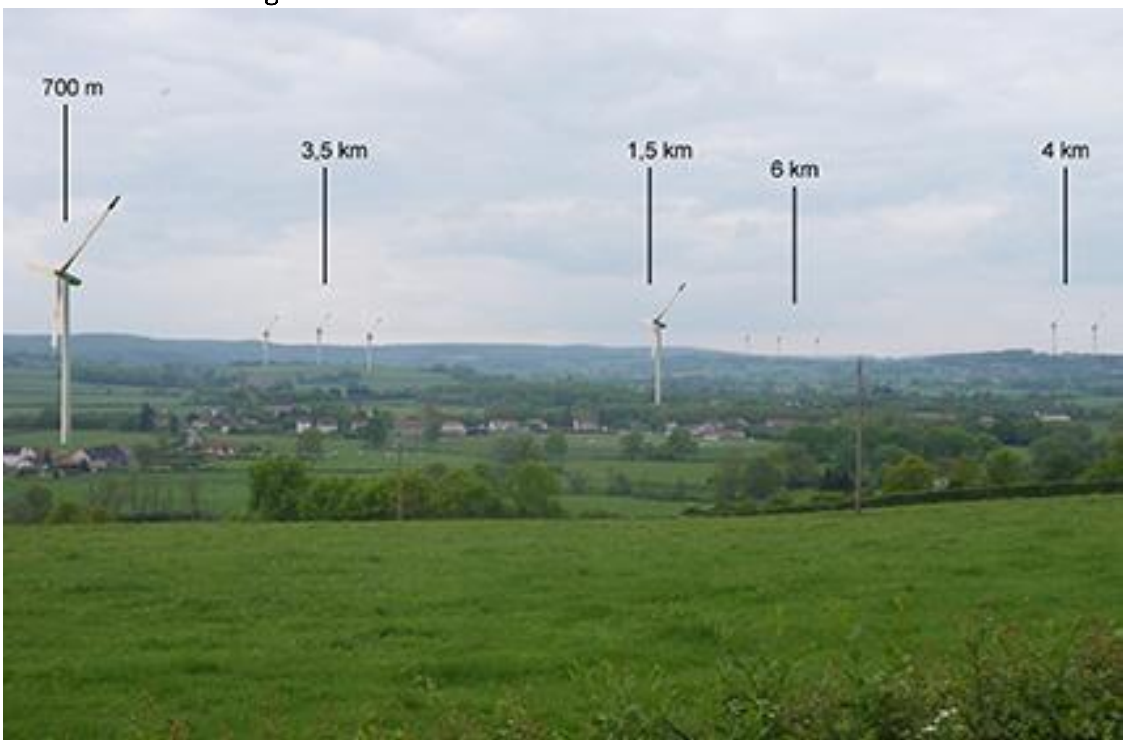
Hammarlund (2002) gave an explanation why some people might view wind power as a practical solution to sustainable development while other people see it as a threat to landscape preservation. For example farmers or other permanent rural residents in agricultural areas are accustomed to seasonal landscape change, which reflects the dynamics of a living countryside. Then such an innovation by wind turbines can add to the dynamics of the rural landscape. But summer residents who are looking for other values such as recreation and recuperation in the countryside look for a kind of historical stability, where, as author says *"wind turbines might not be a soothing or welcome change in the landscape".*

From a planning point of view, the landscape analysis must be focused on the characteristics of the landscape, in such a way that decisions may be made as to the acceptance of the impacts on the landscape. However, the diversity of the characteristics cause difficulties in defining what is significant for the landscape analysis. What makes one landscape more special than another can be tangible (for example, the topography, or the presence/absence of water) or intangible (for example, the level of meaning and personal association to a place) and can be evaluated objectively or subjectively, depending on the analysis approach.

A possible approach is the creation of computer generated moving images, containing a detailed analysis of the community's preferences, the kind of landscapes and their characteristics. Currently the visual perception of the landscape depends on mobility and materiality of space: observation, measurement, and experimentation (BÜSCHER 2006). People see the landscape as they move, not only in the intervals between movements. With the current ease of transport and mobility, the understanding of landscape is now by our moving about in space (BÜSCHER 2006). An educated vision requires a landscape analysis and classification in several areas with values more or less important under certain concepts: Receiver Sensitivity, Magnitude, and Meaning.

All are valid tools to assess a possible change, but currently, the traditional photographs and photomontages are of little help (Image XIV), since people perceive the landscape as they move and photographs are static images. So there are now different tools to help public influence in the process of impact assessment of a change in the landscape. However, this 3D visualization in motion is not enough, there comes the "experimental interactivity" (BÜSCHER 2006). These modern programs, in addition to traditional maps, plans, photographs and scale models can now be submitted and assessed by those who really matters: the resident population.

Image XIV
Photomontage – installation of a wind farm with distances information



Source: http://charlenesweb.fr (27-09-2011)

## 3. Current Situation in Portugal and Sweden

### 3.1- Portugal: A great potential

In 1998 the European Union signed the Kyoto Protocol, compromising to reduce the greenhouse gas emissions in 8%, between 2008 and 2012, in relation to the values registered in 1990. Apart from the economic imperatives, institutional compromises makes Portugal rethink its energy management policy. The fulfillment of the aims negotiated for Portugal within the Kyoto protocol scope and a group of community directives which limit the use of fossil combustion more and more make the need to introduce renewable energies even more urgent (APA 2009). Apart from the ecologic advantages and the low costs associated, the renewable energy sector may equally be an important factor in the promotion of employment (APA 2009).

Renewable energies are a theme which is more and more present in Portugal. This, because the country depends almost exclusively on the energy import of third countries – about 90% of the final consumption, when it has natural conditions to reduce that dependency (APA 2009).

Portugal is one of the European countries that present the most favorable conditions for the usage of renewable energies at a large scale. The reasons are obvious: high solar exposure, a relatively dense hydrographic network and a maritime front which benefits from the Atlantic winds are factors that may make the country's energy invoice expenses come down to half, directly or indirectly responsible for about sixty percent of the national imports. If to these numbers we add the fact that the country presents a minor energy efficiency of the European Union, Portugal puts itself in an extreme dependency position in view of the third countries (APREN 2009).

The electricity produced in the country includes the resource to big dams, nowadays responsible for a big slice of the electrical production, removing a margin to the increment of the small sources of renewable energy.

Amongst the alternatives of energy production which present themselves to Portugal, solar energy – converted into photovoltaic and thermal – is also a privileged source in a country with such climatic characteristics, where the average annual period of solar exposure varies between 2200 and 3000 hours (in the central European countries that incidence does not go above 1200 to 1700 hours) (APREN 2009). Biodiesel, biogas and biomass (efficient in the treatment and in the value of the residues, in the greenhouse contention, with low operation costs), constitute more and more credible alternatives (APREN 2009).

The growing necessities of the internal market and environmental protection laws have made the wind farm energy into one of the most attractive energies among solar energy, hydraulic, geothermic, of the seas and of the waves. The choice is probably based on the efficiency, economic incentives and short prize investment returns. Portugal has made a great effort of wind farm energy investments and its importance for the national economy is notorious. The projections for the advantage of wind farm energy in the renewable energies framework were never so favorable and some results can be seen: the dependency of the fuel decreased for the electricity production and there is also a reduction in the emissions of carbon dioxide.

In view of the growing development of the associated technology the production of wind energy the increase in the number of wind farms installed is foreseeable, and taking into consideration the impacts verified on the environment, economy, population and local development, it is fundamental that the wind farm projects be subjected to the evaluation process of Environmental Impacts Assessment (EIA). In Portugal, the wind farms are placed, mainly, in areas of high conservationist interest (TRAVASSOS ET AL. 2005), which makes the correct evaluation of the impacts fundamental, the suitability of the measures of minimization proposed and the existence of monitoring systems. In the particular case of the wind farms, the projects with 20 or more aero-generators or if located at a distance inferior to 2km from other wind farms are compulsorily subjected to the EIA. The number of aero-generators is reduced to 10 or more when the investment is located in a sensitive area, the distance for other wind farms is kept the same. Under the current legislation in the framework of nature and biodiversity conservation are classified sensitive areas: Natura Net 2000 Sites, Special Conservation Areas, Special Protection Areas and national monuments areas. The EIA process can also consider the electric line of interconnection and receptor, depending on the characteristics of the line (MENDES ET AL. 2002).

In Portugal, the concept of the EIA is introduced into the national politics through the Environmental Basis Law, ordinance 11/87, of the 7$^{th}$ of April, defining it as an instrument of land use planning policy to the previous evaluation of the impact caused by the infra-structure construction, introduction of new technological activities and products susceptible to affect the Environment and the landscape. Also in the Environment Basis Law, references of the Environmental Impact Studies come up, being its approval an essential condition for the final licensing of the constructions and works by the competent services. The legal system of EIA was introduced in Portugal by the 186/90 ordinance, of the 6th of June, amended in accordance with European Directive: Environmental Impact Assessment - (69/00 ordinance of 3 May, which transposes into national law n. 85/337/EC and 2003/35/EC, amended by directive n. 97/11/EC of the council in 3 March 1997, with several changes, the last by 197/2005 ordinance, Nov. 8).

According to the ordinance, the fundamental objectives of the EIA are four: i) Obtain integrated information of the possible direct and indirect effects on the natural and social environment of the projects they are submitted to; ii) Foresee the performance of measures destined to avoid, minimize and compensate such impacts so as to help the adoption of decisions environmentally sustainable; iii) Guarantee the public participation and the query of the ones interested in the decision forming that concern them, privileging dialogue and the consensus in the performance of the administrative function; and iv) Evaluate the possible significant environmental impacts arising from the performance of the projects that are submitted to them, through the institution of an evaluation, subsequently, the effects of those projects in the environment, in view to guarantee the efficiency of the measures destined to avoid, minimize or compensate the foreseen impacts.

The following entities intervene, in the EIA scope: Licensor, which licenses or authorizes the project through the evaluation of the characteristics of the former; Authority of the EIA that, among other competencies, coordinates and administratively manages the EIA procedure and issues a proposal of Environmental Declaration Impact (EDI), posteriorly evaluated by the Minister responsible by the Environment area; Evaluation commission, namely by the EIA Authority, which deliberates on the Scope Definition Proposal of the Environmental Impact Study (EIS), verifies the legal conformity and technical appreciation of the EIS and elaborates the final technical report of the EIA; the coordinating Entity and technical support, figure assumed by the

Portuguese Environment Agency, which assures the functions of general coordination and generic monitoring of the EIA proceeding. The EIA Authority depends on the typology of the Project and territorial coverage. It is a continuous process that should start when there is an intention to promote an action or project and only ends when the project is deactivated.

In a generic way, four stages are considered in the project performance: planning (or project phase), construction, development and deactivation/reconversion (MENDES ET AL. 2002).

Particularly in the case of the wind farms, it is foreseen that the disturbance is reduced in the planning phase and more significant in the remaining phases. This type of venture consists of one or more aero-generators, a command building and a substation, to which the aero-generators are linked by underground cables. Apart from these structures, the access network between the structures and the electric line that link the wind farm to the National Electric Network should also be considered in the EIA process (MENDES ET AL. 2002).

### 3.2- Sweden: an example of experiences

Nordic countries invest a lot in energy efficiency and in renewable energy production. In the last decades, Sweden has gone against a direct relationship between the economic growth and energy consumption, and emerges as one of the world leaders of "clean" energy export. In recent years, the critics of the proposed law to reduce the World dependency of fossil fuels and the emissions of associated carbon which cause climatic changes, have argued that the transition to renewable energies would harm economic growth. But Sweden has shown that the investments done in terms of efficiency and renewable energies can really strengthen economic competitiveness. When the world made the price of imported fuel shoot up in 1973 and 1979, Sweden was between 80 and 90 per cent dependent on fossil fuels (EK 2005). The country established priorities of energy saving and built systems of energy at a large scale, such as the heating of buildings taking advantage of the heat waste of the power plants and industry, or producing heat from renewable energies such as geothermic, hydro, solar or biomass. The housing and construction in Sweden, are nowadays almost free from fossil fuel, and use a combination of urban heating energy, electricity and bio-fuels, thus, doing without fuel import. Apart from the technologies mentioned, many others have commercial potential, due to the available specialization, industrial base, etc. One of those examples is the production of wind farm turbines. The international market of this product is growing in Sweden and there are several industries and an ample knowledge in the area. Sweden has also worked hard in the research and development of renewable energies and low carbon emissions.

Area, and consequently land are directly proportional to the installed power and may represent a strong contribution to the total primary energy supply in Sweden. It is therefore of central importance to analyze the content and function of laws and legal rules concerning the use of land and water areas that are related to the installation of windmills.

In order to the relatively high reduction for energy-intensive facilities in Sweden, operators can also choose an engagement strategy that involves the export of technology, rather than change of energy resources and so on. In the end, the flexibility of market instruments in order to reduce the overall impact on the climate may slow the development of renewable energy compared with other measures (PETTERSSON 2008).

The Planning and Building Law was enacted in 1987 as a result of extensive legislative work. The main thrusts of the reform in the planning system were social development and economic growth that led to an increased demand for natural resources, in part, and a desire to decentralize decision-making by strengthening local self-governance (PETTERSSON 2008). Decisions about changes in land use were thus considered primarily an issue for society, represented by the state and municipalities. Along with the Planning and Building Act came the Natural Resources Act and in 1998, the provisions relating to resource management have been transferred almost entirely to the Environmental Code. In 1997 the Swedish parliament adopted a program of action that promotes a sustainable energy system. The program includes guidelines to promote energy efficiency and increasing the share of renewables in the Swedish energy system. In 2002, the government set out a proposal to promote renewable electricity, and the same year, set a goal of planning an annual production of 10 TWh of wind power in 2015 (UNFCCC 2009). This trend shares the objective of the Directive of the European Union to increase share of renewable electricity.

Among the obstacles regarding the installation of windmills, for example, are the difficulties in obtaining consent which is subject to the planning system, and lack of public acceptance for the installation of wind farms. An increase in installed capacity of wind power also contributes to a number of other policy objectives and legal requirements that follow from international commitments and European Union law. Thus the international level, the adoption of the United Nations Framework on Climate Changes Convention (UNFCCC) and Kyoto Protocol implies a legal obligation, which imposes targets for states to reduce emissions of greenhouse gases.

In Sweden, the application of renewable energy, and in turn, the ability to realize the objectives of national energy policies and international commitments and is partially dependent on the requirements of the law, the fact that cater to a wide variety of interests, shows a need to explore more deeply how well the law corresponds to the desired development of renewable energy (PETTERSSON 2008).

# 4. Case Studies

## 4.1- Objective and Method

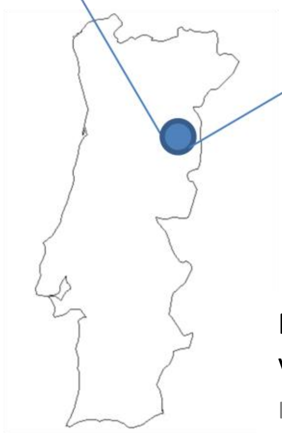
The intention is to study the wind power landscape as something more than just a visual surface, but as something that people might perceive differently and with deeper meaning. And with the case studies demonstrate the perceptions which people have on wind power landscapes using suitable theories and concepts.

For a deeper understanding of wind power landscapes and people perception is necessary to begin with exploring different theoretical concepts about the landscape character and approximate them with the action and interaction of natural and human factors. These concepts will be applied on two case studies that depict the current situation in Portugal and Sweden and the different problems in planning, including the visual and ecological, but more specifically in the cases dealt, the social and technical component integrating these structures in the landscape. In the study are used either information from several publications available on web pages and personal contact with companies.

**4.2- Videmonte Wind Farm**

The Videmonte wind farm consists of installing a set of sixteen wind turbines, a medium voltage network and its substation. It is located in Portugal, county of Celorico da Beira, district of Guarda, in the Natural Park of Serra da Estrela and the Natura 2000 site "Serra da Estrela" (Map I). The process of environmental impact assessment of this project in a previous study has benefited from previous efforts of the bidder in order to install wind farms in the region. Thus, a public consultation on the draft like a wind farm in an area adjacent to Videmonte, Cabeça Alta, in 2001, allowed understanding the conflicts that generated the project with the local practice of paragliding (Paragliding is a recreational and competitive flying sport). Thus, its implementation would eventually fully commit to this sport since, for many people, associations and local authorities were not adequately addressed the minimum distance between the park areas in dropping paragliders. To complicate matters, at the time, there was no legal regulation in Portugal concerning the distance. The insistence of the bidder in the project, now in the village of Videmonte, and publication of minimum distances from the Sports Institute led to the beginning of a process of environmental impact assessment in 2003. Defined thus another location (Videmonte) and a sufficient distance to the areas of launch and landing of paragliders in order to safeguard the safety of these (more than 3 km of the wind farm), avoiding the public outcry and permitting approval. This process of environmental impact assessment, with all these peculiarities, had the effect of getting a project that complied with all local conditions, allowing the implementation of a project better than the original.

Image XV
Videmonte Wind Farm
Source: http://3.bp.blogspot.com (20-06-2011)



Map I
Videmonte location in Portugal
Edited by the author

**4.3- Lillgrund Wind Farm**

The Lillgrund wind farm project consists of installing a set of forty-eight wind turbines. It is the largest offshore wind farm in Sweden and is located in Lillgrund near Malmo, off Sweden's south coast (Map II). The area is bordered, on the west and on the northwest by the navigational fairways to Drogden and Flintrännan, on the east by the navigational fairway Lillgrundsrännan. The water protected area Bredgrund borders the area to the south, but for practical reasons the border between the Malmö and Vellinge communities was defined as the limit.

The Lillgrund offshore wind power plant is located seven kilometers off the Swedish coast in the shallow area of Öresund strait, which connects the Baltic Sea with the North Sea. Lillgrund is 7 km south from the Öresund Bridge connecting Sweden and Denmark. An average wind speed of around 8,5 m/s at hub height, combined with a relatively low water depth of 4 to 8 meters makes it economically feasible to build here. It’s a Swedish pilot project supported by the Swedish Energy Agency (STEM). The bidding process was completed during 2005 and the offshore power plant was constructed in the period 2006 to 2007.

The original permit application requested permission for the construction of forty eight 1.5 MW turbines within the above specified area. There was a requirement that the turbines in the farm should be arranged in rows, such that these rows could be used as a support for navigation. However, the long permit turnaround times led to a situation where the intended wind turbine size was no longer available when permission was finally given. After discussions with the authorities, the 1.5 MW limit was removed, and a more up-to-date turbine model could be chosen. A turbine with a 92.6 meter rotor diameter, 65 meter hub height and a rated power output of 2.3 MW was chosen. With these larger turbines, the spacing between the turbines became very close then it would have been possible to remove some turbines to optimize the layout, but the decision was made to continue with the originally planned layout and, consequently, prioritize maximum production instead of maximum profitability.

Map II

Lillgrund location in Sweden

Edited by the author

Image XVI

Lillgrund Wind Farm

Source: http://tdworld.com (19-06-2011)

#### 4.4- Environmentally sensitive location

- Videmonte Wind Farm

Videmonte wind farm is located in the Natural Park of Serra da Estrela, protected area with a high value in terms of vegetation and wildlife since it is a mountain ecosystem. In fact, this mountain is characterized by its high altitude (the highest in mainland Portugal) and mountain ecosystems are well preserved. May be highlighted the presence of two protected species of bats and eleven species of birds with protection status (ECOSSISTEMA 2004).

Wind turbines are deployed in Serra do Ralo, and the nearest populations, 1 km away, are Salgueirais and Vide Entre Vinhas. These mountain villages are essentially small communities, aging and declining population, whose income comes from farming (potatoes, beans, onions, olive oil), manufacture of traditional artisan cheese and livestock (sheep and goats) (CELORICO DA BEIRA MUNICIPALITY). The abandonment of these sites by the young is due to reduced economic viability of farming mountain systems, and its high physical demands. They have all basic infrastructure (water, electricity, waste collection) and quick access to nearby urban centers. Although located very close to each other, these two villages have unique peculiarities. Vide Entre Vinhas is situated on a plateau and its name is related to the fact that it was a place rich in vineyards. It has two belvederes where one can enjoy the mountain landscape and a very active Folklore Group (which concentrates 50 of the 200 villagers) (CELORICO DA BEIRA MUNICIPALITY). Regarding Salgueirais, its name comes from the ancient abundance of willows. Today the forest consists of pine and chestnut trees, and the wasteland of the Parish Council is the largest forest area of the parish. The main landmark of this village is the dam of Salgueirais, also used by residents and locals as a beach (CELORICO DA BEIRA MUNICIPALITY).

Near this area is still the historical village of Linhares da Beira, sought after for its castle where one can see the vast valley, Vale da Serra da Estrela and Celorico da Beira from distance. Linhares has ideal wind conditions for paragliding and has several schools and an annual international tournament of this sport (in 2010 there took place the Paragliding World Cup) (CELORICO DA BEIRA MUNICIPALITY). Other activities such as hiking and hunting are also common in the region.

- Lillgrund Wind Farm

Lillgrund wind farm is also located in an environmentally sensitive area, inhabited a rich diversity of marine flora and fauna and an important migration route for many species of fish and birds. In the southern part of the Baltic Sea region spectacular archaeological discoveries have been made in connection with submerged settlements, most of which date from between 8,000–2,000 BC.

These discoveries have provided a fundamental new understanding of how people lived and interacted and of their technological knowledge, as well as their adaptation to a changing environment. The Kattegat, Baltic, and Skagerrak Seas, including the Sound (the Öresund strait), are some of the most heavily trafficked sea areas in the world, with a seafaring history that goes back several thousands of years. The number of registered losses at sea within Swedish territorial waters alone counts to more than 3,500 in modern times, i.e. since the registers began in earnest in the $19^{th}$ century. Thus, the actual number must be many times larger. The Swedish cultural heritage act states that preservation and protection of cultural heritage, including archaeological remains under water and on land, is of national importance, the responsibility of which is shared by each and everyone. It must not be disturbed, altered or removed without special permission.

Following the increased need for renewable energy sources, the establishment of offshore wind farms has become an important option for the future. It is often preferable to locate such farms in shallow bank areas at sea, where their visual impact is less intrusive and the winds steadier. As a result, the building and maintenance of wind farms often has the potential to interfere with cultural heritage. Therefore, the impact of such establishments must be thoroughly assessed in order to avoid causing any damage – an approach that will not only protect the underwater cultural heritage for generations to come but also minimize costs for the contractor interested in building offshore wind farms. (VATTENFALL WEBSITE)

**4.5- The sustainability dimension**

Regarding the dimension of sustainability, there are differences in the approach of the case studies. It is clear that both projects are concerned with visual and ecological impacts, but each one has its own specifications. In the case of Videmonte for being a hinterland and less developed, was given great importance to the social systems, while in Lillgrund since it is an offshore project were more detailed the technical aspects related to sea installation and its specific impact on the skyline.

- Videmonte Wind Farm

Analyzing the performance of the project in question notes that tried to compensate and minimize environmental impacts by not risking the integrity of natural systems. The socio-ecological systems have also been promoted with the implementation of the project. Since local people already have all the essential level of basic infrastructure, the concern must go through to improve them and/or encourage the cultural and leisure valued by these people: social groups for socializing and creating new leisure facilities such as a river beach, among many other possibilities.

The implementation of this project has brought economic benefits and promoted the development of the region, benefiting its people in an equitable manner. This measure is further enhanced by the fact that part of the land earmarked for the project are located on communal land and therefore the revenue from renting this also contributed to local community development. The performance of the project will ensure that future generations will be in a better situation than today. Thus, to enable economic development (financial revenue support to local municipal authorities), social (creating new livelihoods in relation to existing facilities with the creation of employment, etc.) and environmental (impacts are small scale and properly secured), the project provides options for future generations.

- Lillgrund wind farm

Currently, wind farms installed offshore or nearshore represent a small portion of the market but they are already a fundamental part of the energetic policies from several countries (EWEA 2009a). The offshore wind farm energy has great potential as resource to supply clean and abundant energy at a global scale, thus being one of the cheapest and technologically advanced renewable energetic sources (LADENBURG & DUBGAARD 2009).

The choice of materials for offshore projects must naturally be more careful than in continental situations. Damage in one of the propellers or the cables may pose high costs of repairs and delays in relation to normal production. It should be noted that all repairs must be madeon the high seas and the cables are buried on the sea bed about fifteen feet deep, and when removed for repair, ditch close by natural causes and will have to dig another. Lillgrund project was constructed on time and has now been successfully operational since December 2007. (VATTENFALL WEBSITE)

Geotechnical investigations offshore are expensive and it can be difficult to balance the risks as well as the benefits of this expense in the early phases of a large infrastructure project. As a whole, the geotechnical surveys at Lillgrund proved to be useful, identifying potential issues and helping to overcome them.

## 4.6- The importance of public consultation

A fundamental part of the communication process is public perception. It is important for the entrepreneur to understand that people are worried about the possible change in their living situation, dealing with that is essential for how people are going to react to the plans of a potential wind farm. The goal was to achieve acceptance from the local residents which helped facilitate the permit process.

- Wind Farm Videmonte

As required during the process of Environmental Impact Assessment in Portugal was promoted a public consultation. The desired location for the Cabeça Alta Wind Farm in Serra da Estrela, did foresee a potential conflict with the practice of parachuting located in Linhares da Beira, where there is an important national festival and a sport school. The results obtained from public consultation showed the dimension of the conflict, and forced the National Sports Institute to establish general rules of safety for the local paragliding - previously unavailable. These rules imposed a minimum distance of 3 km "to the launch ramps or landing sites of paragliders and other practitioners of free flight." The project, meanwhile renamed Videmonte Wind Farm, was relocated to more than 3 km of the local paragliding and was subject to environmental impact assessment.

The new project included the creation of an office of public assistance during the construction phase but, while there were informal register of complaints (conversations between the people and the building owner), was never officially used by the public, which shows that the population did not feel encouraged to participate fully. Thus, the definition of various forms of communication between public and proponent is part of the project concerns to reach all stakeholders and encourage their participation. In this case, informal meetings in the villages would have been more effective, however, took place awareness sessions about the effects of electromagnetic fields, which is a remarkable aspect.

- Lillgrund wind farm

One part of the authority consulting process is to hold open meetings with the public. Two extensive open meetings for the public were held during spring 2005, one in Bunkeflostrand and one in Höllviken. These meetings had high attendance records, and had positive responses to the information opportunities. The local householders' associations and other concerned associations were invited to a number of smaller, more personal meetings. These gatherings also drew a lot of people, many being knowledgeable regarding the project.

Another part of the consulting process is regular meetings with authorities to update them on the project process. These meetings were held with a high frequency, about once a month, to ensure that all relevant information was forwarded to the people concerned and that no new issues were overlooked. The process was very smooth and there was a relaxed atmosphere at the meetings. A continuous dialogue was upheld through e-mail and telephone in between these scheduled meetings. As a result of the proactive public relations work, a lot of positive attention was drawn to the project through various articles in local newspapers. The diligent work on the permit and environmental processes also lead to good relationships with authorities.

## 5. Discussion

All human activities bear impacts. It is up to each one of us to evaluate those impacts, their risks and try to mitigate them in the best possible way. In view to safeguard the minimization or compensation of the impacts caused by the implementation of infrastructures, the Environmental Impact Evaluation (EIE) process was created. For this effect, adequate evaluation of the real risks of the performance and operation of the infrastructures should be carried out, so that the environmental quality of the area will not be compromised at a long/medium term. The evaluation methodologies, prevention and mitigation of environmental impacts will have to be an integral part of the preparation processes and viability of the undertakings.

Within the context of the growing pressure for the development of the exploitation of renewable energies, wind farm energy is nowadays taken as one of the most viable alternative for the electrical production, in view of the usage of combustible fossils. Apart from the acknowledgement of the positive aspects associated, questions as to the proceedings of the Environmental Impact Study (EIS) have been coming up and to the impact caused by the installation of wind farms on the environment. The increase at a quick pace of the number of wind farms is a strong investment that is foreseen in the new future may mean greater pressure on the Protected Areas and Interest Community Places (Natura Net 2000), as well as the threatened population of bird species and the environment in general. However, the actual state of knowledge evaluation shows that it is possible to successfully integrate the capacity of exploitation of the renewable energies and natural values. This posture requires, however, that all the intervenient in the work process (promoters, regional and national authorities, NGO´S and community in general) so as to identify the local necessities and the acceptable environmental alternatives.

The evaluation of the environmental impact (EIA) constitutes the preventive instrument of decision in the last decades developing what best serves the public policies in the Sustainable environment development. This tool makes the analysis and the integration of a set of social and environmental elements possible, the evaluation of projects as well as the technological evaluation, assuring the biodiversity, human health, developing the systems of environmental management to auditing, the risk analysis and the strategic evaluation, promoting the participation of the public, evaluation of the cultural patrimony.

The EIA process appears in order to comply with two fundamental principles of environmental policy: the precautionary principle and the principle of citizen participation (Lei de Bases do Ambiente, 1987), which can be compromised by misguided processes, made by entities directly concerned with very low public participation, no monitoring or further evaluation, representing a system failure that may threat landscapes. The problem is even broader, it can be said that the measures of minimization impacts shown in the evaluation process of EIA are very often generic and not adapted to the project implantation area, very often exhaustive and integrating the essential questions, but also some without any possibility of practical feasibility. The measures of minimization should be better realized and adapted to the typology of the project and location. The approach made by landscape architects and planners, must be made in order not just to minimize negative impacts but to highlight the positive. Poor awareness of stakeholders in the project influence poor management and monitoring.

The issue of wind power landscape attracts great attention due to human sensitivity to vertical and horizontal lines in the landscape (TUAN, 1974). While elaborating people´s perception to Lillgrund, it is suitable to include into discourse also what Nielsen (2002) says particularly about offshore wind farms: *"The visual consequences of offshore locations are different from those that occur on land. Characterized by an unobstructed view, offshore turbines can be seen over long distances, depending on visibility and the play of sunlight on the turbines… based on experience from Denmark's Vindeby offshore project, the power company has concluded that there are no real problems--only advantages - in terms of environmental and public acceptance of offshore sitting".* It is probably too exaggerated when Nielsen says that there are only advantages of public acceptance, but is true that offshore wind farms are in general perceived in better way among people. It is of great importance the public involvement for its acceptance, especially at local level. By the term "local level" are implicit people living near affected by the project within people who have an income from wind turbines. It is interesting to mention also people who appreciate wind turbine in motion. They perceive the structures in much deeper way and are aware of its "meaning" or "function". It is interesting to discuss those concepts of environmental aesthetics from the point of sense of space and place. Each project became a place by the establishment of turbines; maybe it became a place much earlier in people´s mind already during the first discussions about its location. But before each project became a place, the area represented space for people, space which might have had a significant value to them. According to Tuan (1974) we could assign the area to visual space, which was dominated by a broad horizon. This broad horizon offered the view towards the sea and represented a high recreational value, which might have been affected by the establishment of the project. Author also writes that people normally focus on the proximate world, where visual space does not belong. These projects changed the visual space into places with a great visibility which might have caused a resistance among the people, especially on the local level. But as Thayer (1987) says, even this high visibility of wind power landscapes does not express its whole character. It presents a strongly man-made character, which is in his words: "*publicly interpreted as an indicator of man´s callousness toward scenic beauty or as a symbol of society´s conservation ethic and wise use of renewably energy resource"* (THAYER 1987).

When the question of wind power goes more to local level, the image of space moves to the discussion about some particular place. Than it is right the question of public involvement to the planning and management process, awareness of people about renewable energy, which can significantly increase the public acceptance and thus the people´s perception on wind power landscape will probably be in better, deeper way.

## 6. Conclusion

From a planning point of view, the landscape analysis requires an interdisciplinary approach in order to consider the social context and the biophysical features of landscapes. It is necessary to make a holistic evaluation considering all the cultural and natural characteristics and values in the context of the changes presented by renewable energy development. The awareness of the population in general promotes an effective participation of the community which is essential for this process. There are different points of view ranging from the occasional visitor, to the season and the permanent resident or the farmer and they have different perceptions and opinions about the changes in landscape. The landscape evaluation, in a regional scale is essential for the understanding of the relative landscape values (WFLV 2004).

If landscape impacts of the wind farms were evaluated one by one might be important for the detail of the specific impacts of the installation, but one cannot evaluate the importance of these impacts without knowing the relative importance of the landscape in a regional, national and international context. Provided that some landscape impacts are inevitable in the installations of wind farms, and that there is an international pressure for the use of eolic energy as a renewable source of energy, the planning processes should consider a balance between the political concerns and environmental aspects.

Wind power is an efficient source of electrical production having as an advantage the facts of being out of danger, of being clean and of being abundant. These unquestionable advantages of wind farm energy cannot hide the eventual impacts that they can cause. Naturally the environmental impacts are felt since the planning and project, construction, exploitation until the deactivation or possible reconversion of the farm. However, it is in the exploitation and construction that the impacts take on a greater expression.

After this study on the impacts of wind turbines in the landscape, in the following pages were identified the most important criteria to consider when thinking about planning an area for wind energy production:

- Land use

Regarding to land use, the wind farm has the advantage of allowing the land to be used for other purposes, agricultural and pastoral for instance, however one should not forget that the implantation of obstacles or the increase of roughness on the ground implies a reduction of wind turbines. In general the installation of wind farms does not affect significantly the natural habitat. In certain cases, an attempt to exploit the surrounding lands can occur, taking advantage of the lands owing the infrastructures created and its consequent added value. However, with the exploitation of the land and its rents the local authorities may generate some economic benefits.

- Excavations

For the implantation of some wind farms it is necessary to resort to excavations in rocky areas (Image XVII). The consequences of the explosions and taking down of rocks may be troublesome for the nearest residents. In these circumstances should be elaborated a previous study on all the surrounding dwellings. It also imposes a prior compelling of the population (LNEG 2009). Fauna may also suffer serious disturbances.

Image XVII

Videmonte Wind Farm, Striped schist, formation of the soil in Videmonte

Source: http://www.turismo.guarda.pt (20-06-2011)

- Ecological and archaeological values

Especially sensitive zones – with elements and natural areas of high ecological or archaeological value – should be duly marked and enclosed, before the constructions start (INGOLD 1993). Archeological remains can be found during the excavations (Image XVIII).

Image XVIII

Videmonte Wind Farm, Archaeological remains found near the site of excavations

Source: http://www.nemus.pt/pt (19-06-2011)

- Avifauna

Related to avifauna, in certain cases of wind farms placed in bird migration zones (Image XIX), have been observed a high number of dead birds due to the blades rotation, electrocution in the energy transport lines, apart from an evident reduction of the available habitat. A way to prevent these incidents is a correct planning in the localization of the wind farm avoiding, as much as possible, migration routes, dormitory and nidification sites (BARRIOS 2004).

Image XIX

Videmonte Wind Farm, Red partridge (*Alectoris rufa*), one of eleven protected species of birds in the protected area of Serra da Estrela

Source: http://i23.photobucket.com (21-06-2011)

- Visual Impact

Turbines are obviously a great alteration to the scenic quality of the landscape (Image XX). The evaluation of visual impact is difficult and subjective. However, there are some bothersome effects that can be written up, such as: the shadow effect in movement and the intermittent reflex (EK 2005; GAMBOA & MUNDA 2007). The first may be avoided with correct planning of the park. The effect of the intermittent reflexes, due to the incidence of the sun on the blades in movement, can be avoided by using opaque paintings. By painting the aero-generators with the colours of the landscape is a good solution to minimize the visual impact.

Image XX

Lillgrund Wind Farm, Sunset at sea, a privileged view from Swedish east coast

Source: http://v24.lscache8.c.bigcache.googleapis.com (20-06-2011)

- Noise

The emission of noise by the aero-generators is due to the mechanical functioning and to the aerodynamic effect. For aero-generators with a diameter of the upper rotor at 20m the aerodynamic effects are the ones which most contribute for the emission of noises. The recommendable noise level is inferior to 40dB which corresponds to a distance of the aero-generators of 200m (GAMBOA & MUNDA 2007).

- Security

About people security, it has been verified that the wind farms are among the safest systems in the electrical energy production (RUANO 1999). Only rare cases of people injured by pieces of the blades or by loose pieces of ice were registered. In offshore projects the security is related to navigation issues and requires the navigators to choose alternative routes (Image XXI).

Image XXI
Lillgrund Wind Farm, Navigation

Source: http://v1.cache1.c.bigcache.googleapis.com (19-06-2011)

- Monitoring and Environmental counseling

During the implementation phase, the conditions of environmental quality should be guaranteed. Efficiency of the adopted mitigating measures and its impacts must be monitored. That monitoring includes, among other activities, the counseling of the process of landscaping and environmental restoration and the achievement of periodic reviews in order to the maintenance of sound levels of turbines. Particular attention should be given to the monitoring of the existing fauna and habitats in the areas, previous, during and after the construction, making possible to compare the before and the after and evaluate the consequences (TORREMOLINOS CHARTER).

# 7. Reference List
## Paper Material

Anthony, Robert N., 1965. **Planning and control systems**; a framework for analysis, Division of Research, Graduate School of Business Administration, Harvard University, Boston

Assembleia da Republica, 1987. **Lei de Bases do Ambiente**, artº 3º

Barbieri, J. C., 1997. **Desenvolvimento e meio ambiente: as estratégias de mudanças da Agenda 21**. Petrópolis, Brazil

Barclay, R., Baerwald, E.F. and Gruver J.C., 2007. **Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height**. Canadian Journal of Zoology

Barrios, L., and Rodriguez, A., 2004. **Behavioral and environmental correlates of soaring-bird mortality at on-shore wind turbines**. Journal of Applied Ecology 41: 72-81

Birke-Neilsen, 1996. **Wind Turbines and the Landscape**: Architecture and Aesthetics. Danish Energy Agency's Development Program

Büscher, M., 2006. **Vision in motion**, Department of Sociology, Lancaster University, UK

Collett, S., 1995. **Wind farms and public opinion**. New Review: The Magazine of New and Renewable Energy. 25, May, pp14-15

Cosgrove, D. E., 1985. **Prospect, perspective and the evolution of the landscape idea**. Transactions of the Institute of British Geographers, New Series 10 (1): 45–62

Council of Europe, 2000. **European Landscape Convention**, Council of Europe, Florence, Italy

Crowe, S. (Dame), 1958. Cited in **Inspiring Place** Pty Ltd. 2002a. Musselroe Wind Farm and associated transmission line visual values inventory and impact assessment. Appendix 6 in Hydro Tasmania, Musselroe Wind Farm Development Plan and Environmental Management Plan.

DGOTDU (Direcção-geral do Ordenamento do Território e Desenvolvimento Urbano), 2003. **Guia para avaliação estratégica de impactes em ordenamento do território** – Colecção Estudos 9. 1st edition. DGOTDU, Lisbon, Portugal

Drewitt, A.L., and Langston, R.H.W., 2006. **Assessing the impacts of wind farms on birds**. 148: 29-42

ECOSSISTEMA, 2004: a. **Parque Eólico de Videmonte, em Fase de Estudo Prévio** – EIA, 2 volumes; b. **Relatório de Conformidade Ambiental do Projecto de Execução – Parque Eólico de Videmonte**, 4 volumes; c. **Relatório de Conformidade Ambiental do Projecto de Execução – Linha Eléctrica de Interligação do Parque Eólico de Videmonte com a subestação de Chafariz**, 4 volumes; d. **DIA – Parque Eólico de Videmonte** NEMUS; e. **Parecer da Comissão de Avaliação – PE de Videmonte**

ECOSSISTEMA, 2006. **Relatório de Acompanhamento Público - PE de Videmonte** NEMUS

Ek, K., 2005. **Public and private attitudes towards "green" electricity: the case of Swedish wind power**. Energy Policy 33: 1677-1689

Español Echaniz, I., 2007. **Infraestructure and Landscape**. Council of Europe, Strasbourg, 2007

EWEA (European Wind Energy Association), 2008. **Pure power – Wind energy scenarios up to 2030**. EWEA, Brussels, Belgium

EWEA (European Wind Energy Association), 2009: a. **Wind energy – The facts**. EWEA, Brussels, Belgium; b. **Wind energy and research. Wind Energy Factsheets**. EWEA, Brussels, Belgium; c. **Climate protection: more wind power = less CO2. Wind Energy Factsheets**. EWEA, Brussels, Belgium

Gamboa, G. and G. Munda., 2007. **The problem of windfarm location: A social multi-criteria evaluation framework**. Energy Policy 35: 1564-1583

Gipe, P., 2002. **Design as if People Matter: Aesthetic guidelines for a wind power future**. Chapter 9 in Pasqualetti et. al. 2002 Wind Power in View: **Energy landscapes in a crowded world**. Academic Press

Gnansounou, E., A. Dauriat, J. Villegas and L. Panichelli, 2009. **Life cycle assessment of biofuels: Energy and greenhouse gas balances**. Bioresource Technology 100: 4919-4930

GWEC (Global Wind Energy Council), 2008. **Global Wind Energy Outlook**. GWEC, Brussels, Belgium

Hammarlund, K., 2002. **Society and Wind Power in Sweden**. In: Pasqualetti, M.J., Gipe, P, and Righter, R., **Wind Power in View: Energy, Landscapes in a Crowded World**. San Diego: Academic Press, 234: 101-114

Hoel, M and S. Kverndokk, 1996. **Depletion of fossil fuels and the impacts of global warming. Resource and Energy Economics**

Ingold, T., 1993. **The temporality of landscape**. World Archaeology 25 (2)

Ladenburg, J. and A. Dubgaard, 2009. **Preferences of coastal zone user groups regarding the siting of offshore wind farms**. Ocean & Coastal Management 52: 233-242

Lynch, K., 1960. **The Image of the City**. Cambridge Massachussettes, MIT Press

Mendes, L., M. Costa e M.J. Pedreira, 2002. **A energia eólica e o ambiente – Guia de orientação para a avaliação ambiental**. Instituto do Ambiente, Alfragide, Portugal

Muir, R., 1999. **Approaches to Landscape**. Lanham, Maryland , Rowman & Little field

Nielsen, B.F., 2002. **A Formula For Success in Denmark**. In: Pasqualetti, M.J., Gipe, P, and Righter, R., **Wind Power in View: Energy, Landscapes in a Crowded World**. San Diego: Academic Press, 234: 115-132

Norberg-Schulz, C., 1976. **The phenomenon of place**. In M. Larice & E. Macdonald (Eds.), The urban design reader (pp. 125-137), 2007. London and New York

Olwig K. R., 2009. **The practice of Landscape 'Conventions'** and the Just Landscape: The Case of European Landscape Convention. Justice, Power and the Political Landscape

Pasqualetti, M.J., Gipe, P, and Righter, R., eds., 2002. **A Landscape of Power. Wind Power in View: Energy Landscapes in a Crowded World**. San Diego: Academic Press

Patterson , M. G., 1999. **What is energy efficiency? : Concepts, indicators and methodological issues**. Department of Resource and Environmental Planning, Massey University, Palmerston North, New Zealand

Pettersson, M., 2008. **Renewable Energy Development and the role of law: a comparative study of legal norms related to planning, location and installation of windmills**. Doctoral Thesis/Luleå University of Technology, 2008:65

Ruano, M., 1999. Ecourbanism. **Sustainable Human Settlements: 60 case studies**. Editorial Gustavo Gili, Barcelona

Shafiee, S., and Topal, E., 2009. **When fossil fuel reserves will be diminished?** Energy Policy, Volume 37, Issue 1; 181-189

Smith, R., 2003. **Portland Wind Energy Project Panel Report**. Unpublished Report. Planning Panels Victoria.

Stanton, C., 1996. **The Impact and Visual Design of Windfarms**. School of Landscape Architecture, Edinburgh College of Art

Steele, J., 2005. **Architecture Écologique. Une Histoire Critique**. Actes Sud

Thayer, R.L. and Freeman, C.M., 1987. Altamount: **public perception of wind energy landscape**. Landscape and Urban Planning, 14, 379-398

Thayer, R. L. and Hansen, H., 1989, **Consumer Attitude and Choice in Local Energy Development**, Research Summary Report, Center for Design Research and Center for Consumer Research, University of California, Davis

TPWind Advisory Council (Advisory Council of the European Wind Energy Technology Platform), 2006. **Wind Energy: A vision for Europe in 2030**. European Wind Energy Technology Platform, Brussels, Belgium

Travassos, P., H.M. Costa, T. Saraiva, R. Tome, M. Armelin, F.I. Ramirez, e J. Neves, 2005. **A energia eólica e a conservação da avifauna em Portugal**. Sociedade Portuguesa para o Estudo das Aves. Lisbon, Portugal

Tuan, Yi-Fu, 1974. **Space and place: humanistic perspective**. Progress in geography 6,388- 427

UN, 1998. **Kyoto protocol to the United Nations Framework Convention on Climate Change**. United Nations, Kyoto, Japan

Van de Wardt, J. W. and Staats, H. (translation), 1988. **Landscapes with wind turbines: environmental psychological research on the consequences of wind energy on scenic beauty**. Research Centre ROV. Leiden University

WFLV (**Wind Farms and Landscape Values**), draft issues paper, 2004. Australian Wind Energy Association and Australian Council of National Trusts

Wulff, R. T., 2002. **The role landscape plays in relation to Wind Energy Power Stations – what are the possible and appropriate visual outcomes?** Unpublished paper presented to the 20th April Conference on Wind farms in Geelong

WWEA (World Wind Energy Association), 2009. **World Wind Energy Report 2008**. World Wind Energy Association, Bonn, Germany

## Internet Material


APA (Associacao Portuguesa do Ambiente), 2009. APA homepage. Available from: <http://www.apambiente.pt/> (Accessed on March 19, 2011)

APAI, 2009. Ficha de consideração do caso de sucesso em AIA – Parque Eólico de Videmonte. Preenchida por Júlio de Jesus (ECOSSISTEMA). Available from: http://www.apai.org.pt/m1/1229685020c.04.pdf (Accessed on March 19, 2011)

APREN (Associacao Portuguesa de Energias Renovaveis), 2009. APREN homepage. Available from: <http://www.apren.pt/index.php>. (Accessed on March 23, 2011)

Braunholtz, S., 2003. Public Attitudes to Windfarms: A Survey of Local Residents in Scotland. MORI Scotland. Scottish Executive Social Research. Available from: http://www.scotland.gov.uk/library5/environment/pawslr.pdf. (Accessed on March 13, 2011)

Câmara Municipal de Celorico da Beira – Vide entre vinhas: Available from: http://www.cmceloricodabeira.pt/concelho/freguesias (Accessed on March 11, 2011)

CCE, 2002. Relatório da Comissão ao Parlamento Europeu e ao Conselho sobre a aplicação e a eficácia da Directiva AIA – O Sucesso da aplicação da Directiva pelos Estados membros, 138 páginas. Available from: http://ec.europa.eu/environment/eia/pdf/report_pt.pdf (Accessed on March 20, 2011)

CE (Comissão Europeia), 2001. Directiva 2001/77/CE do Parlamento Europeu e do Concelho relativa a promoção da electricidade produzida a partir de fontes de energia renováveis no mercado interno da electricidade. Jornal Oficial das Comunidades Europeias. Available from: <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:283:0033:0040:PT:PDF> (Accessed on April 3, 2011)

CE (Comissão Europeia), 2006. Livro verde - Estratégia europeia para uma energia sustentável, competitiva e segura. Jornal Oficial das Comunidades Europeias. Available from: <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0105:FIN:PT:PDF> (Accessed on April 3, 2011)

CE (Comissão Europeia), 2008. Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. Available from: <http://ec.europa.eu/energy/climate_actions/doc/2008_res_directive_en.pdf> (Accessed on April 3, 2011)

Danish wind industry association: Wind Turbines and the Environment: Landscape Available from: http://www.talentfactory.dk/en/tour/env/index.htm. (Accessed on March 18, 2011)

Gibson, R., 2001. Sustainability appraisal for sustainability-based environmental assessment decision criteria and implications for determining "significance" in environmental assessment. Available from: http://www.sustreport.org/downloads/ (Accessed on March 15, 2011)

IAIA, 1999. Princípios da Melhor Prática em Avaliação do Impacte Ambiental, Tradução de Júlio de Jesus e Maria do Rosário Partidário, CEPGA, Monte da Caparica. Available from: http://www.iaia.org/publications/ (Accessed on March 21, 2011)

LNEG (Laboratorio Nacional de Energia e Geologia), 2009. LNEG homepage. Available from: <http://www.lneg.pt/>. (Accessed on April 3, 2011)

The European regional/spatial planning charter (Torremolinos Charter) – Concil of Europe, Resolution No. 2. Available from: http://www.coe.int/t/dg4/cultureheritage/heritage/cemat/confminist1-15/6eresolution2_en.asp?toPrint=yes& (Accessed on April 3, 2011)

UN, 1992. Report of the United Nations Conference on Environment and Development – Anex I: Rio Declaration on Environment and Development. Rio de Janeiro, Brazil. (Agenda 21) Available from: http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm (Accessed on March 3, 2011)

UNFCCC (United Nations Framework Convention on Climate Change), 2009. UNFCCC homepage. Available from: <http://unfccc.int/2860.php>. (Accessed on March 13, 2011)

Vattenfall website. Available from: http://www.vattenfall.com/en/index.htm (Accessed on April 3, 2011)