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Master Thesis:

Renewable electric energy generation in Spain

Learning from the German case

Ivan Golpe Diaz

Student number: s2145324

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Ivan Golpe Diaz
s2145324

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Ivan Golpe Diaz
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1. Introduction

1.1 Introduction

In the current situation of growing energy necessities, scarcity of some of the typical energy sources and increasing awareness regarding to the environmental related consequences of our development, dominate the renewable energy industry seems to be a main target for every government. Recently, president Obama said in the State of the Union 2011 speech: “We'll invest in biomedical research, information technology, and especially clean energy technology – an investment that will strengthen our security, protect our planet, and create countless new jobs for our people. […] Maintaining our leadership in research and technology is crucial to America's success”. We can extract some important tips from Obama’s words. It was not a secret the importance of have a dominant role within the renewable energy industry. Germany has been proven it since decades ago. The fact that an American president accepts it, and even signals it as “crucial” is mainly outlining that, right now, there is no other choice anymore. In order to support this “first tip” it’s needed to remember that North America was usually following throughout the recent history various oil protection policies (see: Dahl & Yucel, 1995) and has also supported the fossil fuels in fields where the renewable energy (RE) was already proven useful, like electricity generation. For instance, in United States on year 2006, the electric energy generated by renewable energy was just the 9.4% of the total (Appendix 1, Figure 2). It´s worth to outline that in the same year Spain has generated 18.8% of the electric energy by renewable sources, exactly the double than the first worldwide economy (Ministerio de Industria, Turismo y Comercio, 2006). The “second tip” we can extract is directly related with the employment and technologic development. The renewable energy, besides contributing to the reduction of greenhouse gases emissions, is also helping in the decreasing of the energetic dependence, and is being positioned as a very interesting alternative in terms of employment creation and technologic development (Lopez-Peña, Linares & Perez-Arriaga, 2011).

Apart from these economic and political interests, the main target of the renewable energy industry is to reduce the CO2 emissions and avoid the deterioration of our planet and living conditions. Living conditions could be considered as a fuzzy and contested concept. The concept itself is so different throughout the planet that elaborate a precise definition is almost impossible. Nevertheless, it is related with subjects as the pollution of water, air and soil, disposal of industrial wastes and domestic refuse, soil depletion and food production, hazards of adverse effects of drugs, radiation hazards, occupational diseases, and also mental, ethical and moral considerations in the protection of life and environment (Allan, 1971). Philip Berke and Mary Conroy (2000) have described that natural environment has a limited carrying capacity for human life. Not only nature cannot absorb all the toxins and waste produced by humans, but also it cannot accommodate all the results of human developments. This limitation of the natural environment and human activities are supposed to be the cause of global warming, which consequences are mainly negatives and involve among others change in weather patterns, major risk for human health, imperiled wildlife and increase in sea levels.

Due to this, most EU governments adopted measures aimed for promoting Renewable Energy Technologies (RETs). In fact, the EU Heads of State and Government set a series of demanding climate and energy targets to be met by 2020, known as the "20-20-20" targets. These objectives could be briefly descripted in 3 points: 1) A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels, 2) 20% of EU energy consumption to come from renewable resources, 3) A 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency (European Commission, 2010).

The degree of success of the different measures applied to improve RE generation has been variable in terms of efficiency in costs and deployment effectiveness (Hernandez & Hernandez-Campos, 2011). In fact, There is little agreement on what policies are most effective in promoting RETs or even in what it means for a policy to be 'effective.' So on, RE policy-setting can decay into an unwanted chaotic process of seeking only to satisfy stakeholders, while losing sight of the larger and long-term goals that motivated the original interest in promote renewables (Komor & Bazilian, 2004). A clear example of this could be the 2007 Spanish legislation and policies regarding photo voltaic (PV) solar energy. Initially very attractive subsidies to encourage investment and development in the solar electric energy sector in Spain results in a very disorganized and unsustainable process. Hence, next year the government of Spain had to re-change the subsidies and policies applied to PV electricity generation, with the consequent anger of investors. However, this issue will be exposed and discussed in the coming sections.

The promotion of REs and RETs among the EU countries was, and still is, carried out through different policy and legislation perspectives. Most of the countries are applying a Feed-in tariff/premium system (FIT), among them is possible to outline Denmark, Spain and Germany. Far away from the FIT in users' number, the next is the Quota system, applied by Belgium, Italy or Poland. The third system still present in some countries and for specific kinds of RETs is the Tax incentives/Investment grants. Between the few countries still applying this system is possible to find Finland, the Netherlands or Malta (Teckenburg et al., 2011).The system cited by some authors and even by the European Commission as the most effective one is the FIT (European Commission, 2005), and between the users of the FIT system, the two more frequently used as an example of successful application are Spain and Germany (Ragwitz et al., 2007).

Focusing on Spain, the greenhouse gases emissions, despite the recently reduction, mainly associated with the economic crises and the drastic reduction of the building activity, is still over the limit agreed with the European Union (EU) in the share of Kyoto's protocol obligations. In 2008, before the crises showed his real deepness, the greenhouse emissions were 50% over the emissions registered on 1990, and it was not a good notice at all, taking into account that Spain's limit was 15% over 1990 reference (Lopez-Peña, Linares & Perez-Arriaga, 2011). Regarding to policies, Spain has been cited as an example for its success to get more RETs in place through a feed-in tariff (FIT) system, but there are serious concerns about their rising costs (Hernandez & Hernandez-Campos, 2011), that will be broadly analyzed afterwards.

1.2 Aim and brief data introduction

The aim of this research is to design a big picture through which answer an initially simple question, that will probably result at last, not so simple: Why is Germany producing 6 times more electric energy in 2007 with solar panels than Spain, having the half horizontal solar irradiation? (Appendix 2, Figure 1). It is obvious that it is not something that happens from one day to another, the historical development regarding RE throughout the last 30 years in both countries is the most probable reason for this imbalance. Among the main reasons that assumed to contribute to this difference, are the different political and institutional approaches to solar energy in Spain and Germany. It will be also this difference the central focus point of this research. The focus on the institutional aspect is chosen because it embraces partially other factors, like economy, society or technology. It is to say, the institutional regime of a country is deeply sharped by his economic, social, political, legal, spatial or topographic situation, not just nowadays, all throughout the history. Hereby, it's supposed by the author that going through the institutional aspect of this issue, a broad and clear standpoint to answer the previous question is expected to be reached.

The relevance of this question is not just related with the big difference between the data itself, (Ger: 3075GWh to Spa: 501GWh) (Appendix 1, Figure 1) it is also related with the willingness of German institutions to promote and invest on this technology for which they were not optimal located, in geographical terms (Appendix 2, Figure 1). So, by extension, the other side of the question is why the best geographically located country in Europe haven't made this effort, or has made it too late? Taking a closer look to the other RES we could start wondering if maybe it was not a mistake of Spain, maybe it was a wise move of Germany.

For example, regarding to the biomass industry Germany has been always in front of Spain. In the beginning of the 90s a small growing difference was the trend, but after year 2002 Germany has experimented an important raise in the biomass electricity and heat generation, reaching a huge difference on year 2010 (Ger: 25760TOE to Spa: 6188TOE) (Appendix 3, Figure 7). Here we have a similar situation, Germany has produced in 2010 five times more heat and electric energy through biomass than Spain, but what is different here? Paying attention again to the figure 7 (Appendix 3), we notice that during the 90s Germany was in fourth position regarding biomass electricity and heat generation, after France, Sweden and Finland. It was not until the boost of 2002 and 2003 when Germany reached the dominant position in Europe, talking on terms of biomass. Even now, with 25750TOE, is not so far away from France, with 14360TOE, or Sweden, 11390TOE (Appendix 3, Figure 7).

Nevertheless, going back to the PV solar generation, and enlarging our scope to cover not only Spain and Germany, but also the next four countries in PV solar electric energy generation capacity, impressive data appears. Regarding 2007 data, Germany has produced eighty nine times more electric energy with PV solar panels than Italy, and Italy is the third in the top, just after Germany and Spain. The situation has changed a bit, and in the last data available Germany was producing on year 2010 twice more electric energy through PV solar panels than Spain, but still seven times more than Italy, and twenty times more than Czech republic or France, the last ones in the top 5 in Europe (Appendix 3,

Figure 3), all of them countries also better located regarding the horizontal solar irradiation levels (Appendix 2, Figure 1).

According to this data, one of the countries worst located geographically in the EU in terms of solar horizontal irradiation (Appendix 2, Figure 1), is the biggest producer of solar electric energy by far. In fact, with the last data available, on year 2010 Germany has produced a bit more than the 50% of the whole electric energy produced by PV solar panels in the EU-27 (Appendix 3, Figure 3). How can it be possible? What smart decisions has Germany taken from the RE deployment point of view? And what was happening meanwhile in Spain? Why the best EU located country regarding solar power has reacted so late?

As was stated before, we have indeed many factors that influence this difference: economic, social, legal, etc. But the institutions and the legislation produced by them could be considered in part as a reflect of these other variables. In a first sight to all this empirical data, it's easy to discern that an important and permanent support should have been given from the institutions to encourage this big development and implementation of REs and RETs in Germany. It was since the start a long term approach to change the energy industry. The different German governments along the years have noticed the huge investments these first solar panels required, and the few outcomes they were producing, but it was an investment in a future industry what, coming back to Obama's words: "…will strengthen our security, protect our planet, and create countless new jobs for our people." For instance, in the first roof programme implemented from 1991 to 1995 (the 1000 roof programme) the applicants received 50% funding of investment costs from the federal government and another 20% from the land government (Lauber & Mez, 2004). Hence, in order to answer why this institutional support has not appeared in Spain or what could be the reasons of this lack a theoretical framework will be presented in the next section.

1.3 Abbreviated description of coming sections

The *section 2* of this work relates to the methodology applied in this research and consequently, in the obtaining of the outcomes. It is very important to choose the right methods in order to get an interesting and wide research perspective and fruitful outcomes. Usually, a research paper is trying to convince the reader that the work is significant, relevant, and interesting; that the design of the study is sound (Marshall & Rossman, 1995); and that the tools applied and the scope reached were the right ones. Following Yin (1984) advices, the research present in this paper should be treated as an explanatory one. The characteristics and research methods related with this kind of researches are mentioned and chosen inside the section. Furthermore, some important decisions which deeply shape the work are also taken and properly justified.

In *section 3* a theoretical framework is presented, analyzed and explained. This theoretical framework is expected to help in the research carried out in the electric energy field and in the development of findings and recommendations throughout the thesis. It is mainly based on the analysis of two phenomena: the path dependence and the socio-institutional inertia. Path dependence could be defined as an idea that tries to explain the continued use of a product or practice based on historical choice, preference or use. This stays true even if newer, cheaper and more efficient products or practices are available due to the previous commitment made. Path dependency occurs because it is often easier to simply continue along an already set path than to create a new one (Liebowitz & Margolis, 1999).It is quite a simple definition, but the issue is much more complicated. Inside the mentioned *section 3* a deeper analysis will be carried out.

The socio-institutional inertia could be considered as a phenomena that arises from the own path-dependency of a nation or a territory in a specific field in terms of its resources and the inherited status quo (Pihkala et al., 2007). So on, applying these both concepts to a very complex, multi-actor and monopolist prone sector like energy, and more specifically electric energy, the threaten of lock-ins and lock-outs is noteworthy (Pihkala et al., 2007; Unruh, 2000; del Rio & Unruh, 2005) A lock-in is a capacity that could be developed by the techno-institutional complexes (TIC). This capacity is basically the skill to "close" a specific sector to new challenging technologies that could fight for the dominance of the field. Lock-in and lock-out are two sides of the same coin, but seen though different standpoints, the one inside or the one outside. The concept of techno-institutional complex was also introduced through a new sub-framework, the techno-institutional framework. These both concepts are mainly defining the conditions of the systems which are able to develop lock-ins and lock-outs. Deeper research will be carried out below regarding these concepts. But the important question is still remaining: How is all this supported? Why does the average citizen never hear about the institutional inertia, or the path dependency, or the government´s stance regarding this one or the other lock-in? These are very tricky fields, but in order to cover the whole spectrum of possibilities in my study the risk to enter should be taken.

Discourses determine what can and cannot be thought about an issue, delimit the scope of policy options available and thereby serve as precursors to policy outcomes (Keller & Poferl, 1998; Litfin, 1994).It is to say, the discourse is being prepared to delimit the scope of thinking in the listeners, and thus make it fit perfectly with a bunch of previously prepared solutions. However, how is possible to avoid the rise of critical voices? In words of Flybverg (1998) "Power determines what counts as knowledge, what kind of interpretation attains authority as the dominant interpretation. Power procures the knowledge which supports its purposes, while it ignores or suppresses that knowledge which does not serve it. […] In open confrontation rationality yields to power".

The Spain background and current situation is analyzed in the *section 4.* The different policies, legislation and institutional movements regarding the use of RE in the production of electricity started on the early 80s. It has defined the first legal framework for RE production, but was mainly focused on hydropower. On years 1997 and 1998 different legislation is approved in order to liberalize the electricity market in Spain and introduce the first feed in tariff (FIT) system. The FIT is basically a policy mechanism designed to encourage the investment in REs and RETs. This objective is achieved by offer contracts with specific prices to RE producers for the electric energy they will produce. Both of these legislations were drafts, or haven't really worked properly. In fact, the Spanish electricity market was not really liberalized and the FIT system was not working properly for most of the RES until the year 2003.

On year 2004 the government change, and the PSOE (Partido socialista obrero Español) takes the power until 2012. Within that period, it's worthy to outline some legislation changes. In 2004, some additional characteristics are implemented to the FIT: electric generators under the special regime can choose between two options: 1) a regulated tariff 2) a market price plus a premium. In 2007 the FIT is changed getting closer to the German one. Spain has with this legislation change the most attractive FIT in the world for solar PV electricity generation. Due to this attractive policy, government budget capacity gets exceeded and the government has to change again the "rules of the game" next year (2008), with the consequent anger of the investors. In 2012 a new government party take the power, the PP (Partido Popular) and in his second month on power (January 2012) announces between a huge cuts package the total suppression of any FIT or subsidy to new RE projects. They are even nowadays, at July 2012, thinking on apply retrospective reductions in the FITs that are already applied to projects built and functioning before January 2012 announcement (RDL 1/2012).

In *section 5* an overview about the German policies and legislation is carried out. The interest of this is to compare in *section 6* both countries at the institutional level and through the identification of the differences, maybe find out what was wrong on each place, and find a possible solution for the nowadays very deteriorated Spanish RE industry. Germany started to think in terms of RE industry on the 70s, time in which the country started important investments in R&D regarding this field (Breyer et al., 2010). In the early 80s the first tariff to support RE was introduced. The first Electricity feed-in act (StrEG) was applied in 1991, and it was the foundation of the current legislation regarding RE. In this document Germany was giving to the average citizen free access to the grid. It means, everybody with surplus electric energy could sell it and get profit. Mainly to recoup the cost of the RET installed. German government was already setting a fixed price for 20 years, in order to prevent a rapid decrease in the price of electric energy and break the amortization plans of the investor. Another interesting legislations and institutional movements were the 1000 roof programme, implemented in 1989, and the 100000 roof programme in 1999 (BMWi, 2010). The 1991 Electricity feed-in act mentioned above was revised and renamed on 2000. This new act was called Renewable energy act (EEG) and was also revised and updated on 2004 and 2008. The current Germany trend is to continue with this long-term strategy towards RES to compensate the closing of all their nuclear power plants by 2022 (Lehr, Lutz & Edler, 2012).

The legislations, policies and institutional movements of Spain and Germany are compared in *Section 6.* These both countries are normally cited as an example of successful implementation of REs and RETs (European Commission, 2005; Ragwitz et al., 2007). They are mentioned together because of their most similar characteristic regarding RE, the application of a FIT system. Even being their most common characteristic the application policy was a bit different with some undesirable outcomes to Spain which will be discussed later. The comparison is carried out following a time line with the main policies and legislations applied for both countries regarding RE and RET implementation and development. It was done in this way to stress the most different characteristic of both approaches, the "implementation route". Whereas Germany was betting since the beginning for a long–term and energy diversified approach, Spain was first supporting only the hydropower, and long time later just a serious support to the wind industry was added. Later on, tried to encourage a rapid development of solar PV with very attractive policies but didn't get the expected outcomes with this short-term approach. Another important difference appears in the way to address the subsidies and aids oriented to renewables. Germany was since the 90s applying policies and legislation changes towards companies, of course, but also towards the average citizen, waking up important values about the importance or the RE sector. Spain, in the other hand, was usually letting out of the RE development the individual citizens and the households. Only some tepid movements were made, but not enough to change or arise new social values. The current situation is getting even more worrying for Spain with the halting of every subsidy or institutional help to every kind of RES, meanwhile Germany has planned to invest 200 billion € in RES in the next years.

After a review of the previous sections, and more carefully the last one related with the comparison of both countries, the conclusions and advices are present in *Section 7*. The conclusions were in some cases already expected. For example the hard opposition to the implementation of REs and RETs of the meso-level, which embraces the path dependency and socio-institutional inertia among other determinant factors. Nevertheless, unexpected outcomes were also present. For example the capital importance of a socially approach in the different policies and legislations in order to gain social support and change the social values towards renewable. Or the important role of an unstopped and continuous long-term approach independent of the color of the government in power. It was also unexpected the intrinsic relation between these last two factors commented. The advices were elaborated to cope with the problems emerged through the evaluation of the conclusions, and meanwhile some of them are quite difficult to apply in this times of economic crises, another ones will be a good approach to don't let die the relatively successful Spanish RE industry.

Ivan Golpe Diaz
s2145324

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2. Methodology

In order to find the soundest research strategy, Yin (1984) suggests three questions. The first one is about the form of the research question. Is it mainly exploratory? Does it seek to identify and describe some phenomenon? The second relates to the nature of the phenomena, and the third one concerns the time in which it occurs or has occurred.

The different answers to these questions address us to choose the right research strategy. Yin (1984) is identifying five different strategies: experiments, surveys, archival analyses, histories, and case studies. Some additional ones like field studies, ethnographies or in-depth interviews are mentioned by Marshall & Rossman (1995) and presented in the following explanatory table.

Table 1: Matching research purpose and questions with strategy

Purpose of the study	*Research question*	*Research strategy*	*Examples of data collection techniques*
Exploratory			
To investigate little-understood phenomena To identify/discover important variables To generate hypotheses for further research	What is happening in this social program? What are the salient themes, patterns, categories in participants´ meaning structures? How are these patterns linked with one another?	Case study Field study	Participant observation In-depth interviewing Elite interviewing
Explanatory			
To explain the forces causing the phenomenon in question To identify plausible causal networks shaping the phenomenon	What events, beliefs, attitudes, policies are shaping this phenomenon? How do these forces interact to result in the phenomenon?	Multisite case study History Field study Ethnography	Participant observation In-depth interviewing Survey questionnaire Document analysis
Descriptive			
To document the phenomenon of interest	What are the salient behaviors, events, beliefs, attitudes, structures, processes occurring in this phenomenon?	Field study Case study Ethnography	Participant observation In-depth interviewing Document analysis Unobtrusive measures Survey questionnaire

Predictive			
To predict the outcomes of the phenomenon To forecast the events and behaviors resulting from the phenomenon	What will occur as a result of this phenomenon? Who will be affected? In what ways?	Experiment Quasi-experiment	Survey questionnaire (large sample) Kinesics/proxemics Content analysis

Source: Marshall & Rossman, 1995

According with the information extracted from table 1 the research present in this paper would be mainly classified as an Explanatory one, with perhaps some influences from the Descriptive research as well. The aim of any Explanatory research is to explain the forces and causal networks which cause a determined phenomenon. It fits quite well with the purpose of this research, trying to find and outline the different policies, legislations and institutional movements which could have made the difference between Spain and Germany regarding RE industry. The Descriptive influences could be found in the hard work developed in order to document the phenomena, and also in the turn followed towards explain some structures and processes involved on it.

The research study follows a logical path. First of all, the development of a theoretical framework helps us to define the scope through which the phenomenon will be studied and analyzed. The scope chosen is very important, because it will deeply influence the outcomes of the research. The second step is analyzing the history of both study cases. It will give us a perspective of what has been different in the two different countries within the renewable electric energy field. An exhaustive and right addressed analysis is fundamental here. As it was stated before the focus of this research is at institutional level, including the policies and legislations emerged from them, but was also argued above the reason of this choice.

Taking the policies, legislations and institutions as research objective, it’s been taken also an important part of the social, economic or technological factors. It is because the former ones are somehow a consequence of the others, or at least, they are deeply shaped by the society, the economy or the technology available.

Marshall & Rossman (1995) mention the ethnography as a strategy to approach an explanatory research. It’s not worthless to outline that in the field of study, the REs and RETs, society is a capital factor, if not one of the most important ones as it will be showed in the coming sections. Anyhow, although this variable is not exhaustively analyzed, it is taken into account and is clearly reflected in the different policies, legislations and institutional movements in both study cases.

Regarding the techniques of data collection, this research is mainly based on data acquired from the analysis of documents. It was decided because since some years ago, and also nowadays, the different official documents, academic articles and all kind of information regarding renewable electric energy are crowding the information sources. Therefore, taking into account that the main core of this research is stressed in the history of both countries regarding policies, legislations and institutional movements towards the renewable industry, the analysis of documents should hold a capital position. Furthermore, the available documents are not just restricted to the history description, there are plenty of studies mentioning plausible future scenarios, future trends in the RE industry, or even focused on the idea of adapt a whole country to produce the 100% of electric energy by RES.

In the table 2 the different documents consulted and analyzed are presented. A balance between the sources was sought since the beginning in order to record the data in the most balanced way possible.

Table 2: Different documents consulted

Governmental and official organisms	**Academic articles**	
BMU (2009)	Archer, C. (2005)	Lipp, J. (2007)
CNE (2010)	Arthur, B. (1988)	Loorbach, D. (2010)
Cowan, R. (1996)	Berke, P. R. (2000)	Madeley, J. (1999)
DENA (2006)	Beck, U. (1995)	Mez, L. (2007)
EIA (2007)	Christensen, C. (1997)	Munda, G. (2008)
Eurostat (2007)	Contreras, A. (1999)	Pihkala, T. (2007)
Eurostat (2012)	Dahl, C. (1995)	Pursell, C. (1972)
FMENCN (2010)	Del Rio, P. (2007)	Ramos, A. (2007)
BMWi (2011)	Dominguez, E.F. (2007)	Richardson, T. (2001)
GREA (2010)	Flyvbjerg, B. (1998)	Rip, A. (1998)
IEA (2001)	Grotz, C. (2005)	Rotmans, J. (2001)
IEA (2003)	Hajer, M. A. (1995)	Staffan, J. (2004)
Krazat, M. (2006)	Hajer, M. A. (2005)	Unruh, C. (2000)
Ministerio de Fomento (2006)	Harmaakorpi, V. (2004)	Utterback, J. (1994)
Secretariageneral de energia (2006)	Hernandez, F. (2011)	Volkmar, L. (2004)
Prognos, E. W. I. (2010)	Komor, P. (2005)	Weitzel, M. (2012)
Schweiger, H. (1999)	Lauber, V. (2004)	Wüstenhagen, R. (2006)
European Commission (2010)	Lehr, U. (2012)	

NGOs and other organizations	**Newspapers, blogs and other internet sources**
Alla, F. (1971)	Abc news (2011)
Barclay, R. A. (2009)	Bada, J. (2011)
Greenpeace (2003)	Breyer, Ch. (2010)
IDEA (2010)	Elvira, R. (2012)
Könnölä, T.(2007)	Encinar, J. (2012)
KPMG (2009)	Europa press (2012)
MEDGAZ (2007)	Goldman, A. (2012)
Ragwitz, M. (2007)	Haluzan, N. (2008)
Rakhorst, A. (2010)	Here comes the sun (2008)
Reiche, D. (2004)	Higgs, R. (1995)
REC ASA (2009)	Leyton, S. (2010)
Ruiz, M. E. (2003)	Liebowitz, S. J. (1999)
RWI (2009)	Scheer, H. (2009)
Schurig, S. (2006)	Tradingeconomics (2012)
Teckenburg, E. (2011)	Wang, U. (2009)
	Williams & Moos (1961)

Source: Own elaboration.

In order to avoid biases, and due to have used only the document analysis as information acquire method, the balance previously commented between the sources was a really important issue. Nevertheless, as it was argued before the information available in documents regarding this field study is very wide, and different sources can be chosen even for the same topic to compare them, and contrast the information. Moreover, the number of official papers available covering every possible sub-field was also an important reason to question the need of interviews or surveys in this research.

The need for interviews was also questioned due to the difficulty to design a series of interviews through which a balanced outcome could be obtained. This balance refers not only to geographical terms (which would be already a big issue, due to the huge distance between the countries in analysis), but also regarding to the criticism levels and positions towards RE and RETs deployment. In fact, the authors/sources of the information used in this research embrace a wide scope regarding this criticism level mentioned above. For example, between the most critical ones, we can outline MEDGAZ (2007), RWI (2009) or Hernandez (2011); and between the less critical, we have of course Greenpeace (2003), IDEA (2010), or a documentary called Here Comes the Sun (2009). The mid-term, with no position in the issue, is brought by the numerical data and statistics.

Related with the former issue discussed, another important characteristic of this research is the promotion of a great transparency. Document review properties are also contributing in this sense, it is unobtrusive and nonreactive: “It can be conducted without disturbing the setting in any way” (Marshall & Rossman, 1995). One more advantage is that the method is explicit to the reader. It is say; everything mentioned in the text could be checked by facts or data. This last characteristic was the one which tip the balance in favor of use the document analysis method, because most of the statements present in the text could be checked in the numerical data and graphics obtained from the EU or national governments.

3. Theoretical Framework

3.1 Theoretical introduction

As Richardson & Sharp (2001) have observed, the selection and implementation of environmental related policies is inevitably a complex and messy process with all kind of interactions that relate with the wide and not always clear concept of environment. In this point, once the environment/nature concept is classified as a contested one, it is inevitably to suppose that different standpoints would bring a quite different definition of it. With the word environment, or nature, we mostly refer to the "natural environment" and it means the sum of all living and non-living things surrounding an organism, or group of organisms. The natural environment embraces all factors, elements, and conditions that could have impact on growth and development of certain organism. It also includes both biotic and abiotic factors that have influenced observed organisms (Haluzan, 2008). However, alternative definitions could be found regarding the standpoint we are taken. Due to this, a study of discourse will allow us to see how a diversity of actors actively tries to influence the definition of any environmental problem. This is because reality, and in a similar way environment, are socially constructed. So on, the analysis of meaning becomes central; in order to understand environmental policy research, it is not the concept of environment that is important, but the way in which society makes sense and is conscious about this concept. For instance, the reason for public attention and concern that polluted rivers receive is not incorporated on themselves. The fact that they do receive this attention at a specific place and time is extracted from the symbols and experiences that govern the way people think and act (Beck, 1995, p. 47; Hajer, 1995).

In addition, "incomplete or asymmetric information, inconsistent and/or poorly defined goals, conflicting stakeholder viewpoints, and all the various flaws of the political process make policy-setting both challenging and imperfect" (Komor & Brazilian, 2004). This is clearly evident in the formation of renewable energy (RE) policy. Many countries are pursuing for a greater use of renewables. However, there is little agreement on what policies are most effective in promoting renewables. As a result, "RE policy-setting can easily decay into a chaotic process of seeking only to satisfy stakeholders, while losing sight of the larger goals that motivated the original interest in renewables" (Komor & Bazilian, 2004). Two main reasons could be discerned here. First, the lack of a good structured long-term programme received as inheritance, mixed with the willing to solution the problem with a very aggressive short-term plan. The already hackneyed idea of obtain outcomes in just one term of government (four years), in order to present something to the voters and get re-elected. And the second explanation could be found out in the words of Flyvbjerg (1998):"…institutions that were supposed to represent what they themselves call the "public interest" were revealed to be deeply embedded in the hidden exercise of power and the protection of special interests". It's say, search to satisfy the stakeholders from the public institutions, waiting for something in return.

It's always very difficult to prove this kind of behaviors, but the list of Spanish ex-ministers and high rank politicians inside big energy companies is not short. For example, Elena Salgado vice president of Spain's government between years 2004-2008 and economy minister from 2008 to 2012 is now in a high rank position in Endesa, one of the biggest Spanish electric energy companies. Or, Felipe Gonzalez president of Spain between years 1982 and 1996 is nowadays in the advisor committee of Gas Natural, the biggest gas and electric company in Spain and South-America (Encinar, 2012). The list continues with Eduardo Zaplana (Iberdrola), Josep Pique (Applus), Pedro Solbes (Enel), etc... (Encinar, 2012). The problem of this widespread behavior is the suspicions which can appear, retrospectively talking, about some of the decisions taken in the past from their public positions. Some rules should be implemented in order to shape the relations between companies that basically make business with the institutional regulations and legislations and the politicians or political parties, the ones who make/push/allow them.

The possible dangers associated to the relation between politicians and big corporations favored by their legislations were already stressed by US president Dwight D. Eisenhower in 1961. In that year, president D. Eisenhower talked about the Military-Industrial-Congressional Complex in his farewell discourse (Williams & Moos, 1961). The concept of Military-Industrial-Congressional Complex refers to the policy and monetary relationships between legislators, national armed forces, and the defense industrial base that support them (Higgs, 1995). Between the advantages of these relationships it’s possible to outline: political approval for spending, political contributions, and lobbying to support bureaucracies (Pursell, 1972). The analogy is not direct with the Spanish energetic sector, because huge differences are present between the fields (defense and energy) or the countries (Spain and US). Although at phenomena level the possibility that Spain (and by extension other European countries) were suffering a similar process related with complex monopolistic prone sectors like energy is quite high.

However, the goal of RE policy appears simple: to get more renewables in place, but a closer look reveals that there are in fact many goals that renewables are supposed to accomplish. Let’s just remember what Obama has said “…strengthen our security, protect our planet, and create countless new jobs for our people”. Accordingly REs and RETs can be seen as a way to reduce carbon emissions, to promote industrial development, to decrease fossil fuel imports, to accelerate the employment rates and also to meet other policy goals (Komor & Bazilian, 2004). Nevertheless, it would be naïve to think that policies are the only instrument shaping RE implementation or RETs development. Many other factors should be taken into account, like social acceptance and implication or private’s capital willingness to invest. Although after study the theme, the two basic factors which become revealed as the main influent ones are the path dependency and the socio-institutional inertia. Both of them are indeed, intrinsically related with the policies adopted, or even more precisely, with the policies not adopted by the different national and international government organisms. However, a closer look to their meaning will clarify the implication both of them have in the development and implementation of REs and RETs.

3.2 Path dependency

Apart of the brief definition of path dependency given in the introduction: “…idea that tries to explain the continued use of a product or practice based on historical choice, preference or use. This stays true even if newer, cheaper and more efficient products or practices are available due to the previous commitment made. Path dependency occurs because it is often easier to simply continue along an already set path than to create a new one" (Liebowitz & Margolis, 1999), we do have to distinguish between three different degrees of path-dependency.

In the first-degree we have a decision taken by the influence of initial actions, maybe insignificant ones that put us on a path that cannot be left without some cost. This path could be optimal, but not necessarily the uniquely optimal. This degree of path dependence is normally not harmful at all (Liebowitz & Margolis, 1999). One example could be the path which crosses an empty field of grass. Someone was the first person on walk through the field and let the footprints in the grass. Probably the next person will go through the same footprints, and so forth, the path is created.

The second-degree path dependence is related with the imperfection of the information available, or a certain lack of knowledge in the field. Experiencing this lack of information/knowledge the efficient decisions taken in the past may not always appear to be so efficient in retrospect. But the inferiority of the chosen solution was unknowable in the time the choice was made, even when later we recognize that an alternative path would have yielded better outcomes. However, there is not inefficiency because of the information/knowledge limitation in the time of the decision (Liebowitz & Margolis, 1999).

An example might be lack of promotion of PV solar panels in Spain during the years 2001 to 2007. In these seven years Germany multiplied her PV electricity generation capacity fifty one times (from 60GWh to 3075GWh) (Appendix 1, Figure 1). Both countries were investing in RE, and in this year 2001 Spain reached Germany in electric energy per capita generated through windmills (Appendix 1, Figure 3 and Figure 4; Appendix 3, Figure 2). Retrospectively, the wise decision on that time would have been maintain the wind subsidies but at same diversify the RE industry towards the PV generation addressing part of the wind facilities to encourage PV solar electricity generation. The point is that maybe the Spanish government or institutions had not the same amount of information regarding PV technology than the German government. We have to take into account that Germany was investing strongly in R&D related with RET since the 70s (Breyer et al., 2010), and probably they had much more knowledge in order to decide if promote or don't the PV electricity generation industry. This is one hypothesis, but another one is also present. There is the possibility that the Spanish government had almost the same amount of information than the German government, but some other forces have persuaded them. It was argued above that sometimes high-rank politicians finish their careers working for important energy companies. It's not the intention of this research to blame anyone, but the entrance on this tricky field is mandatory to embrace all the scope of possibilities. In fact, it is just a conjecture made in basis of previously mentioned Flyvbjerg´s (1998) words about hidden exercises of power and protection of specific interests from public positions. Moreover, the third-degree path dependence is deeply related with this last commented behavior.

The third-degree is also dependent on initial conditions but leads to an outcome that is inefficient. It's say that some more feasible (in absolute terms) arrangements or paths were recognized in the time of the decision, but they were not taken into account (Liebowitz & Margolis, 1999). The second hypothesis mentioned in the example of second-degree dependence fits perfectly with this concept. But there are also more valid examples. The current Spanish government has cut totally the subsidies to renewable energy, but at same time has kept the subsidies to the coal extraction of Asturias' mine sector (see Ruiz de Elvira, 2012). It's indeed a third-degree path dependence case, but something is different in this example. There is social conflict, the economy of a whole region is in the edge (important portion of Asturias, and some parts of Leon), commitments to the sector were also made time ago and many other external factors. In these complex situations of third-degree dependence is when the concept of socio-institutional inertia arises.

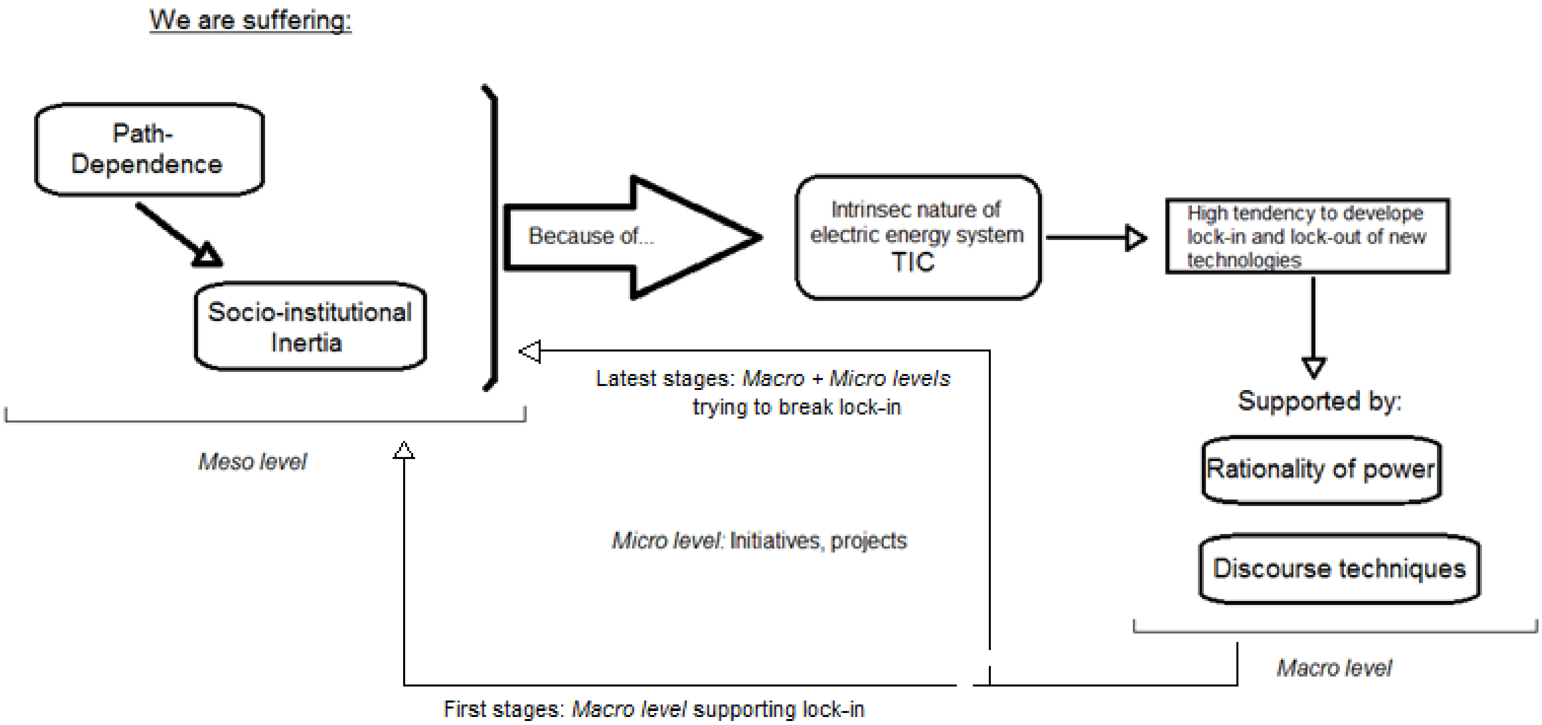
3.3 Socio-institutional inertia

The socio-institutional inertia could be understood as something that shapes the development of an area, field or sector. This inertia arises from the path dependency in terms of its resources, technology and status quo of social contracts, that is, lock-ins (Pihkala et al., 2007). The idea of socio-institutional inertia could be, in a subconsciously way, related with the first and second degree of path dependence in the very long term; although is mainly similar to the third-degree of path dependence. The bases are the same: don't choose consciously the optimal path/solution even when the information/knowledge is available, but the characteristics and conditions surrounding the problem are much more complex.

Trying to make it a bit clearer, a valid example for the third-degree dependence would be to buy the Xbox360 instead of the Playstation3, because most of your friends have the Xbox, even knowing when the decision is taken that the Xbox is a worse videogame platform than the Playstation3. Taking the same situation, a valid example of socio-institutional inertia would be that the Playstation3 was not commercialized on your country, and then a bigger effort would be needed to do in order to get your videogame platform. Nevertheless, this example is only an explanatory one, and is not at all related with the electric energy sector. The Asturias' mine sector previously mentioned is the most clear example of socio-institutional inertia nowadays in Spain, although is still a bit confusing because of the high complexity related with this phenomena in a field like electric energy generation. Therefore, the previous example with the videogame platform seems to be also needed in order to clarify the concept.

In order to support and clarify these ideas, some different and more specific concepts will be introduced. In the first case, a new framework will be cited: the techno-institutional framework, and through this scope the next step will be also introduce the notion of Techno-Institutional Complex (TIC), to support future statements. In the Fig. 1 (next page) we can see a scheme that summarizes my vision of the problem.

Fig 1. Scheme of the situation



Source: Own elaboration

Before start talking about these new concepts itself, a brief introduction about the "macro", "meso" and "micro" levels that somehow embrace them should be performed. This division in different aggregation levels fits closely with the one used by Rip and Kemp to analyze changes in socio-technical systems, namely the division into niches, regimes and socio-technical landscapes (Rip & Kemp, 1998). The macro-level refers to political culture and coalitions, social values, paradigms, demography or natural environment. The meso-level is composed by the interests, rules and beliefs that underlie politics. In the micro level we have the individual actors, technologies and local practices (Rotmans et al., 2001).

3.4 Techno-institutional framework.

"New technologies […] do not enter into a virgin market terrain, but instead must compete with pre-existing technologies that currently provide similar services" (del Rio & Unruh, 2006). It is basically the first idea that shows us the unequal competence that will be developed in the arena, in our case, the electric energy. This unequal competence conditions will trigger in the appearance of a technology block, or lock-in/out. This phenomenon that will be explained below is caused by the Techno-Institutional Complex (TIC) nature of the energy systems, but what is a TIC?

"TIC are complexes composed of large technological systems and the public and private institutions that govern their diffusion and use" (Unruh, 2000). Due to the impossibility of large technological systems, like for example electric energy distribution, end and use, to be perfectly understood as a set of discrete technological artifacts, the TIC appears. Nonetheless, these large technological systems can be seen as complex systems of technologies embedded in a highly conditional social context of public and private institutions. These systems develop through path dependence, socio-institutional inertia and co-evolutionary processes involving the technological infrastructures, organizations and institutions that create, diffuse and employ them (Unruh, 2000; Pihkala et al., 2007). In the moment they have already locked-in, displace them is a very difficult task. They can lock-out alternative challenging technologies during long periods, even when the alternatives show great improvements and more efficiency (Unruh, 2000; del Rio & Unruh, 2006). Due to the induced power given by the dominance of the sector and the indirect control over policies and decision-making procedures, they are able to determine what counts as knowledge […]. "Power procures the knowledge which supports its purposes, while it ignores or suppresses that knowledge which does not serve it" (Flyvberg, 1998), and that's why alternative technologies can be ignored for long periods of time.

Energy systems can be identified as TIC, and "they emerge through a path-dependent process driven by increasing returns to scale, which powers their growth and ultimately fosters numerous sources of quasi-irreversibility or lock-in" (Könnölä, 2007; del Rio & Unruh, 2006). It's commonly argued that these complex systems were probably the responsible of important technology lock-outs all along the history, even before the appearance of the "lock-in/out" concept itself.

The focus of the techno-institutional framework is at the level of complex technological systems like electricity generation, telecommunications and transportation that rely on network relationships among complimentary technologies, organizations and governing institutions. TIC surge through path dependence, socio-institutional inertia and co-evolutionary processes which start when several new technological variants are created and start to compete in an environment of technological increasing returns to scale (Arthur, 1988). This competition finish being dominated by one of these variants, and the winner lock-out the other technological architectures (Utterback, 1994). The surviving dominant producing companies who want to continue in the market design a lock-in around standardized decision routines, core competencies, distribution networks and customer–supplier relationships. These movements condition their capabilities to invest in non-dominant technologies, contributing even more to the lock-in strength (Cristenssen, 1997). With the expansion of the system, industry networks and complementary industries, like for example financial institutions, also appear and lock-in coordination standards, relationships and capital investment patterns. When the system starts to look socially pervasive, advocacy groups, voluntary associations and the media shape a discourse that could socialize the system, adapting preferences and expectations to continue the system dominance (del Rio & Unruh, 2005). Finally, maybe government has to interfere in system growth for policy reasons (national security, universal service, etc.) and promote system expansion through subsidies, incentives or outright ownership. The intervention of government, trying to override market forces, signals the appearance of a techno-institutional complex, and probably a lock-in (del Rio & Unruh, 2005).

A brief definition of lock-in was presented in the introduction, but due to the importance of the concept related with the electric energy system, another standpoint will be visualized. When appears the possibility that a technology/routine/tool can become so entrenched that it is virtually impossible for the market to challenge its dominant position without external help, we can consider this phenomenon as a lock-in (Cowan & Kline, 1996).

An example of this commented lock-in within the Spanish electric energy system nowadays could be glimpsed taking a look to the contracts with the gas companies and importers. The gas consumption in Spain was increasing moderately since 1994, but in between years 1996-1997 the electric energy produced by gas increased from 7,49TWh to 19,32TWh, it is an increment of 150%. However, since year 1997 until year 2007 this trend continued, reaching in 2007 the quantity of 93,80TWh. In fact, the share of resources in the electric energy generation in the year 2007 in Spain was 33.4% to gas, more than $^{1}/_{3}$ of the total (European commission, 2010). It was made following the guidelines dictated by Europe, searching for a change to a more environmental friendly energy production (European Commission, 2010). The problem starts when the trend is not halted in time, or is not measured carefully. For instance, promoting the recent construction of the MEDGAZ gas pipeline under the Mediterranean sea that connects the gas sources of Algeria with the south-east coast of Spain, the Spanish government is consciously, or unconsciously promoting a gas lock-in. This project has been planned since long time ago, but due to lack of technology to build in such deep seabed it was postponed. Finally the project was carried out, and finished in 2009, but it is not working yet. An important stakeholder taking part in this project is Endesa, company merged last year with Gas Natural, building the corporation Gas Natural-Endesa, setting up the biggest gas and electric company in Spain and South-America. The gas consumption in Spain in the year 2010 was 34 bcm, that is to say 34 thousands of millions of cubic meters (Appendix 3, Figure 8) from which only the 0,14% is coming from Spanish territory (Index Mundi, 2010) and the MEDGAZ project can guarantee a supply of another additional 8 bcm/year (MEDGAZ, 2007). Its say this project can supply an additional 20% natural gas. Assuming that Spanish government will use this energy, the share of gas would reach almost the 50% (42% exactly) as electric energy generation source. The idea of be dependent on 42% of electric energy generation within one resource that is coming from outside of the country, is not clean energy and is not helping to develop a new long-term industry does not sound like a decision made with a long-term perspective.

The problem is not just the lock-in they are producing today; the big issue is the path dependency and socio-institutional inertia they are letting as inheritance. Because “history matters” and new technologies have to adapt to pre-existing infrastructures, both physical and institutional, created by previous investments and policy decisions (del Rio & Unruh, 2005). Let’s say that Spain wants, like Germany (Rakhorst 2010), to become independent of fossil fuels in electricity generation by year 2023, what will happen with this huge engineering work of 900 million €? It will hardly shape the decisions took in this respect, and will probably slow down this hypothetical transition. But, is it so easy? Won’t appear some voices claiming for a more sustainable electric energy system? Probably they will appear, but in words of Flyvbjerg (1998) power defines reality, and therefore a set of carefully shaped discourses could avoid the appearance and expansion of alternative reasoning paths.

In Table 1 are shown the more common types of lock-in.

Table 1: Types of lock-in and generation sources

Type of lock-in	Source
Technological	Dominant design, standard technological architectures
Organizational	Routines, hierarchies, customer–supplier relations
Industrial/System	Industry standards, technological interrelatedness, value chain relations
Societal	System socialization, adaptation of preferences and expectations
Institutional	Government policy intervention, legal frameworks, departments/ministries

Source: del Rio & Unruh, 2005

In the current Spanish electric energy system individual initiatives and projects, even at households level are getting more and more common, despite the few help from institutions or legislation. At the macro-level the discourses are also changing and a closer approach towards renewable is the main trend. As it was showed in the first paragraph of this research, even an USA president has made an important turn towards renewable in his discourse. Nevertheless, a big gap is still present between what is said and what is applied. The hard "changing point" can be identified at the meso-level, several energy lock-ins can still be identified (coal), and some of them are even being fed (gas). Natural environment consciousness and social values changes at macro-level are starting to be felt by the development of these individual projects at micro-level, but a loss of power is also being experimented by the different national governments. Big corporations and merged energy companies are starting to gain more and more power, being able even to influence the political decisions taken at national and international level (Madeley, 1999). However, with some wise changes in the approach towards REs and RETs, and the pressure from the other aggregation levels, a relatively fast and continuous change in the meso-level is expected in the coming years.

The development of this theoretical framework based on power-rationality and discourse theories at macro-level, path dependence and socio-institutional inertia at meso-level, and the techno-institutional complex and its capacities to develop lock-ins at micro-level is expected to help the development of findings throughout the analysis and comparison of both countries under study. The intrinsic nature of highly complex systems like the electric energy sector to develop lock-ins, moving afterwards towards path dependence and socio-institutional inertia, is initially supported and even promoted by the power and the discourses emitted by the power. However, these positions are susceptible to change. Having a clear idea about these concepts, and the initial behavior in their respective aggregation levels the coming sections will test the feasibility of this tools in order to find outcomes and sometimes advices which could help to develop better approaches towards RE and RETs deployment.

4. Spain, Historical Background

4.1 Overview

Spain is composed by 17 autonomous regions. Each one of this region has its own parliament. Although Spain is the second largest country in European Union with about 505,000 km2 it is not very densely populated. Most inhabitants live in the capital Madrid and in large cities in the coastal areas (IEA, 2001). Nevertheless, in 2011 about 47.1 million people lived in Spain, it is the fifth most populated European Union country, with a density of 93.51 hab/km^2 (INE, 2012).

Spain has experienced an important economic growth during the last 25 years. Especially industrialization, the joining of the EU in 1986 and a flourish construction industry contributed to this growth (Bickert, 2008). As in all developed economies, services are the largest sector (66% of GDP in 2007). Tourism is also very important being Spain the world's third-most popular tourist destination after the United States and France. Retailing and banking are also gaining importance. The country's industry is accounting 30% of GDP. The biggest part contributed by construction, with a 14% share of GDP in 2007. Other large subsectors are vehicle manufacturing, energy industries and food-processing. The primary sector (mostly agriculture and fishing) is accounting 4% of GDP (IEA, 2009).

After more than a decade of rapid economic growth, the outlook has changed with the bursting of the housing bubble and the international credit crunch. Growth slowed from 3.7% in 2007 to 1.2% in 2008, falling to around -0.1% in 2010 (Trading Economics, 2012). Unemployment has increased from 9% in January 2008 to more than 17% in May 2009, reflecting on the last statistics of May 2012 an unemployment rate of 24.4% (INE, 2012).

During the growing time energy consumption increased as well with a high rate and there has been considerable investments in energy systems infrastructure and capacity. The energy and electricity market had to restructure to fulfill the growing energy and electricity demand after 1986. As a matter of fact, the electricity consumption per capita was 6,000 kWh in 2006 (INE, 2012).

Energy imports have risen in Spain due to the important and continuous increasing energy demand. This has led to greater energy security concerns. In 2004, Spain had an energy dependency rate of 77%, and although the Spanish energy market is highly diversified in comparison to other EU countries, Spain is mostly dependent on petroleum products (Bickert, 2008). In the past 15 years all kind of RE and RETs developed substantially, but mainly the wind power industry.

Electricity consumption increased irregularly since 1980, but taking an average value we would be talking about a 3% growing (Appendix 1, figure 6). In these years, shortly after the second international oil crisis, Law 82/1980 on energy conservation was enacted, representing the tepid start of the development of renewable energies in Spain. The main objectives of this law were to initiate the rising of energy efficiency, and to place some constraints to the energy dependence (IDAE, 2010).However, the major source of Spanish electricity generation comes from solid fuels, which is also Spain´s major domestic energy resource. Hydro, another important resource for electricity production in

Spain was strongly encouraged by the government after the 916/85 royal decree. It could be considered the first real bet of any Spanish government related with renewable energy. Nonetheless, hydro fluctuates in its contribution and thereby influents not only the other resources but also the share of imports and exports. Therefore the goal of energy security was not one of the targets within the promotion of hydro energy. When the share of electricity production was about 40% to the hydro at the beginning of the last century, its share decreased over the time due to the construction and initiation of thermal power plants and later nuclear power plants (Bickert, 2008). Nevertheless electricity generation by hydro power plants is still a substantial resource with a share of 12% in 2004 (Eurostat 2007).

In 1998, the government prepared some new relevant legislation. First, the introduction of the "Electric Market" due to which some new energy technologies could sell the electric energy at market price plus some bonus. And second, Spain and Portugal forms the Iberian electricity market (MIBEL).Since the Memorandum of Agreement, signed on 29 July 1998, the administrations of the countries aim to increase cooperation in case of energy. Although Spain and Portugal have much in common in case of electricity production and its current situation, there are differences in geography, economic and energy terms (Domínguez et al. 2007). The main characteristics of MIBEL are free competition, transparency, efficiency and a single price for the whole peninsula (CNE, 2012).

Afterwards, some other regulations are implemented: RD 2818/1998, RD 436/2004, RD 661/2007. All of them redacted in order to "provide stability in the long-term" to the sector. Nevertheless, it is worthy to outline another movement in between: In the year 2003 the electricity markets are fully liberalized, at a faster pace than required by the EU (IEA 2001), because although the electricity market was liberalized since 1997, it was not working as a fully liberalized one until the year 2003 (Ruiz, 2003).

In the following table (Table 2) the Spain Policy Chronology is described. Most important subsidies and policies for the different REs and RETs are illuminated. The feed-in tariff system will be briefly explained in a subsection below. Note that beside the governmental policies local authorities play an important role in the development of REs and RETs. Legislation varies among regions, and regions often have their own renewable energy plans and different incentives to promote renewable energy through investment subsidies (IEA 2004).

Table 3: Spain Policy Chronology for renewable energy resources.

Policy Instrument	Year	Type	Technology	Description
Energy Conservation Law	1980-1994	Guaranteed Prices	All RES	First legal framework for support of RES; special regime from which hydro (≤5MW) and other could profit
Renewable Energy Programme	1991-2000	Regulatory and administrative rules	All RES	Promotes energy security and diversification

Electricity Law	1994-1997	Guaranteed prices	All RES	Reorganization of Spain´s electricity industry; guarantee on purchase contracts 5 years
Royal Decree	1994-1997	Guaranteed prices	All RES	Specification of electricity law
General electricity law	1997-present	Guaranteed prices/feed-in tariff/obligations	All RES	Liberalization of electricity sector; guarantee electricity supply at lowest possible costs; elaborated plan for achieving 12% primary energy consumption from RES by 2010; special regime for producers which are not allowed to surpass a max. of 50MW power
Royal Decree: "special regime"	1998-2004	Feed-in tariffs	All RES	Increase of feed-in tariffs
Renewable energy promotion plan	1999-2010	Obligations	All RES	Supply 12% of total energy demand with energy generated from RES by 2010
R&D priorities	1999-2003	R&D	All RES	National Plan on Scientific Research and Technology Development and Innovation: more efficient, less polluting energy systems, energy transmission, sorting, distribution, use, reduction of CO_2 emissions
Feed-in tariffs for small scale co-generation/Renewable energy production	1999-2004	Feed-in tariffs	All RES	Generators with capacity ≤50MW have right to sell electricity to the grid at a pre-set price, or market price+premium
Plan on renewables	2000-present	Obligations	All RES	Doubling the renewable energy share from 6-12%
R&D Energy Programme	2000-2003	R&D	All RES	Integration of specific programs
Royal Decree	2000-2007	Feed-in tariff	Solar PV	Standard contract and invoice for solar PV installations connected to voltage grids

National Energy Programme of the promotion of Technical Research	2000-2001	Capital grants; R&D	All RES	Facilitate the integration of renewable energy and the environmental and socio-economic aspects of energy; grants for industrial research and technology demonstration programs
Law on fiscal, Administrative and Social measures	2001	Investment tax credits	All RES	Corporate tax deductions for investments in RES; 10% tax deduction
Inter-ministerial commission for Biomass	2001-2010	Regulatory and administrative rules	Biomass	Promote package of measures and remove barriers to the development of biomass
Aid programme for solar PV and solar Thermal	2001-2003	Capital Grants	Solar PV, Solar Thermal	As part of renewable action plan; subsidies for solar thermal and solar PV projects started in 2002 and finished before October 2003
Low interest loans	2001-2012	Third-party finance	All RES	Provides investment assistance to renewable through low interest loans
Modification to the biomass, waste and wind energy premiums	2001-2010	Guaranteed prices/feed-in tariffs	Biomass, Offshore wind, Onshore wind, Waste	Increasing of premium for biomass, livestock manure management, decreasing of premium for wind energy
Planning and development of the electric and gas transport networks	2002-2011	Regulatory and administrative rules	All RES	Gives priority to installations of power lines coming from renewable energy facilities and for combined cycle power plants; increase installed capacity of wind to 13,000 MW in 2011 and of combined cycle power plants to 14,800MW by 2011
Royal Decree	2002-2004	Guaranteed prices/feed-in tariffs	All RES	Specification of changes to the special regime, regulating installations producing energy from renewables and the incentives for them
Royal Decree	2004-present	Guaranteed prices/feed-in tariff	All RES	Electric generators under the special regime can choose between two options: 1) a regulated tariff, 2) a market price plus premium.

Royal Decree	2007-present	Guaranteed prices/feed-in tariff	All RES	Change in FITs and introduction of highest and lowest prices (cap and floor)
Royal Decree	2007-present	Regulatory and administrative rules	Wind and Tidal power	Establishing administrative procedures for the authorization of offshore electricity generating facilities
Royal Decree	2008-present	Guaranteed prices/feed-in tariff	Solar PV	Changes in the Solar PV feed-in tariff
Royal Decree	2012-present	Regulatory and administrative rules	All RES	Halting the pre-assignment of retributions and abolition of the economic incentives for new REs

Source: IEA 2004, IEA 2009, CNE 2012&Bickert, 2008.

As a result of this favorable legislation and policies much of the diversification of the electricity production occurred during the past 10-15 years. The increment of the demand has played also an important role in this trend. In particular the shares of natural gas and wind increased, and solid fuels decreased dramatically. Today natural gas power plants are the main resource for electricity production in Spain, with 33.4% of share (2007) in comparison to rather 1.6% in 1990 (European commission, 2010). Wind grew from 0% in 1990 to nearly 6% in 2004 (Eurostat 2007). Solid fuels decreased from 39.3% of share in 1990 to 24% in 2007 (European commission, 2010). This trend will be probably halted due to the Royal Decree 1/2012, in which the economic help and support are suspended indefinitely for new REs and RETs (CNE, 2012).

4.2 Feed-in tariff

The feed-in tariff was initially developed in United States with the Public Utility Regulatory Policies Act in 1978, being afterwards adopted by many countries. The typical examples of feed-in tariff countries are Denmark and the two present in this research: Germany and Spain (Leyton, 2010). The feed-in tariff is a policy mechanism what encourages the development of REs, by the establishment of a guaranteed price for each unit of energy injected in the net. This guaranteed price is frequently higher than the price paid normally to buy the power, because they are designed to support the implementation of energy projects which would not be profitable without this help (Barclay, 2009). The rates stipulated on each contract depend on the cost generation of each technology. For example, the FIT is much higher for solar PV installations than for hydropower facilities because of the associated costs and position in the learning curve of each technology. Feed-in tariffs in Spain and Germany are generally applied to: biomass, solar PV, small hydro, wind, cogeneration and waste treatment.

Spain is still supporting renewable energy by premiums/feed-in tariffs for electricity paid by final users, tax exemptions on bio-fuels, and investment subsidies (mostly for heat use in residential sector) in the installations in operation or those that are already registered; but the FIT is suspended to the new REs and RETs.

Although these policies have succeeded in rapidly increasing supply, especially of wind, solar, PV and bio-fuels, they do not come for free (IEA, 2009).In fact, "FIT are the most effective system to a rapid deployment of RETs, but when it is in place the installations capacity (in MW) increase spectacularly, often with undesirable effects. For example, in the future some RETs could not survive financially unless their subsidies come at the expense of customers" (Hernandez & Hernandez-Campos, 2011). It means the policy to get RE implemented is being effective, but nor efficient in costs.

As a matter of fact, Spanish feed-in tariff resulted at the end not so successful in solar PV. For instance, in the case of solar PV sector in Spain, a very attractive feed-in tariff was set together with a national cap of 400M which was supposed to last from 2007 until 2010. The 344MW were already reached in September 2007, leading the government to an important dilemma. Decide if to raise the cap and adjust the rates, or not. The government finally did and changed the "rules of the game", but everybody wanted to stay within the "old rules". Therefore, every project tried to finish as fast as possible, and some GW were finally installed in 2008 (Wang, 2009).

It sounds like good news for the RE development, but it was not. Why? According to the words of Tom Werner, CEO of Sun Power in San Jose, California "If you look to Spain with its feed-in tariff, Spain was No. 1 in solar market. It's now going to be the 10th or 15th and difference is policy change. There was a gold rush, and now almost all the solar installers are gone"(Wang, 2009).A mistake in policy implementation can cost to Spain some years of delay in an increasingly importance industry like solar energy.

As it was argued before a very aggressive short-term approach in these very complex fields is not always giving the expected outcomes. A long-term approach to the solar PV industry, and a more moderate ambition to lure investments would have avoided this problem. Maybe not so many solar panels would be still installed, but the trend would be a continuous growing curve.

Another point to improve is related with the connection system between the RE producer and the distributor. Normally, PV generators have medium voltage grid connection, and have to install a transformer to connect the electricity produced through PV to the net. The Spanish Solar PV Association (ASIF) claims that this is a hidden lock-in promoted from the conventional electric utilities. On the other hand, a policy implemented in the basic construction legislation paper in 2006 (Documento basico HE, 2006) signals the installation of a RET in every new building as mandatory; which was a smart movement in RE deployment terms due to the high construction rate present in Spain back in those days. Nevertheless, the bureaucracy associated with the RET installation, and subsidies related with them is quite complex and varies significantly depending on the region (Greenpeace, 2003).

4.3 Spain potentials

Following slightly the previous topic this subsection will start outlining the solar horizontal irradiation capacity of Spain, being by far the best located country in Europe regarding this aspect (see Appendix 2, Figure 1), having almost double solar horizontal irradiation than Germany. Regarding hydropower potential, Spain could be considered in the second step, after France, Italy and Norway but in the same step as Germany, and 1 further than United Kingdom (see Appendix 2, Figure 2). Talking about wave resources, Spain would be also in the second step, with Portugal, France and Norway, being overcome only by United Kingdom and Ireland (see Appendix 2, Figure 3). Spain is not so good located regarding to wind potential, being overcome by almost every European country (see Appendix 2, Figure 4).

But this statistic is quite unrealistic, because in Figure 4, the wind speed is evaluated at 80m high from sea level. The optimal work position for a windmill turbine is under 150m and with around 14-17 m/s wind speed (Bada, 2011). But wind is faster as you rise your position, so in Spain due to the topographic characteristics (Appendix 2, Figure 5), is possible to raise the windmills position in order to get better wind speeds. When the position rises up to 150m, the turbine starts to lose 3% of capacity each 300m (Bada, 2011). It´s say, until 450m high, the windmill turbine will work at 97%. Hence, sometimes is better to raise the wind turbines in order to get the right wind speed, even losing 3% of capacity each 300m. Taking this into account we notice the real Spanish potential.

4.4 Brief conclusions

Spain has started quite early in the introduction of policies and legislations regarding RE, in 1980 concretely. The main problem was the passivity during the next ten-fifteen years. Afterwards, some programs and policies were implemented, but they were mainly addressed to big companies and to the wind energy industry, forgetting the average citizen but creating a healthy wind industry. The institutional movements, oriented to biomass or solar energy, were mainly disappointing from the investors and consumers point of view. Nevertheless, an important try to develop the Spanish PV capacity was made in 2007 promoting a very high and fixed (0% regression rate) FIT. The movement achieved a great deployment rate, but overcame the government expectations and budget, being changed again next year with the consequent anger of the investors. Despite of its favorable geographical situation, the Spanish government has nowadays halted every subsidy or economic help to all new RE or RET project.

5. Overview German situation and legislation

5.1 Overview

As a response to the first oil crisis, Germany, like so many countries, began to consider RE and supported the sector through R&D funding, starting in the mid-1970s (Breyer et al., 2010). The main effort went, however, into fuel switching away from oil towards more coal and nuclear energy (Lauberand Mez, 2004). A RE tariff was introduced in 1979 to stimulate demand for renewable electricity, obliging electricity distribution companies to purchase RE produced in their supply area based on avoided costs (Lipp, 2007).

The Chernobyl nuclear accident in 1987, combined with growing alarm about climate change around the same time, marked the beginning of a new energy policy era in Germany (Lauber & Mez, 2004). Public opposition to nuclear power was as high as 70% within 2 years of the Chernobyl disaster and a public climate-change commission in 1991 recommended deep cuts in CO_2 emissions (30% by 2005 and 80% by 2050) (Lipp, 2007). The need for a fundamental change in energy policy was first articulated at this time (Reiche, 2004). This helped propel development of the first policies to stimulate a RE market in Germany in the late 1980s: a wind and solar promotion programme offering a substantial subsidy and the creation of a legal basis to require utilities to pay higher costs for RE (Mez, 2007).

The first electricity FIT bill was passed and became law in 1990. The foundations for the current energy policy were built in 1991 with the implementation of the StrEG (Electricity Feed-In Act). This initiative of some members of parliament aimed for a free access for every producer of power to the electricity grid (Wüstenhagen & Bilharz, 2006) and require utility companies to buy electricity from renewable sources at nationally fixed prices .The rationale was to create a level playing field between RE and conventional electricity generation, which reflected the external costs of fossil fuel and nuclear energy (Lipp, 2007). Its successor, the EEG (Renewable Energy Act), has just led to the milestone of a 20% share of renewable energy sources in the German power supply. The rapid growth of renewable energy sources in Germany made that a whole new industry has developed and the costs of energy will keep on decreasing. In fact, combined with the subsidy programme, the first FIT was a great boost for the wind sector, helping to expand the market from 20MW in 1989 to more than 1000MW in 1995 in electricity (Grotz, 2005).

The FIT in Germany has been supplemented by a number of other measures aimed to bring technologies up the learning curve. R&D investment has grown significantly since its beginnings in the 1970s (from 10 million€ in 1974 to almost 2 billion€ between 1990 and 1998) (Lauber & Mez, 2004). According to the EEG, an annual regression of FIT is stipulated. The regression rates range from 1% to 2% per annum for most generation technologies and up to 9% for solar to reflect declining implementation costs and technology devepment. However, instead of being applicable for given facilities, the regression only is applicable for new additions because technology is moving up the learning curve. Once a facility is installed and registered, a fixed rate is paid for a set duration (Weitzel, 2012).

Besides this EEG, there are also other measurements taken by the German government to 'green up' the society, according to the Federal Ministry of Economics and Technology (BMWi) (BMWi, 2010).There are low-interest loan programmes, planning privileges for wind projects, training programmes geared towards RE installations in various professions and public information campaigns. The solar industry has been helped along through an expanded solar roof programme (starting with 1000 roofs in 1989 and upgraded to the 100,000 Roof Programme in 1999). The German government implemented an ecological tax reform in 2001 that introduced a tax on the consumption of electricity and raised the level of tax on fossil fuels (except coal) (Lipp, 2007).

The big success of renewable energy in Germany started in 1991 when the Electricity Feed-In Act was adopted. Every household which invested in renewable energy sources was now a potential energy supplier; since the energy grid was freely accessible for the surplus power they produced (Scheer, 2009). For a better understanding of what this act really means, we take a closer look how this policy stimulates citizens and private corporations to invest in renewable energy sources.

5.2 Electricity Feed-In Act

In Germany there is already a history of legislation concerning renewable power production. According to the German Renewable Energy Agency, little attention to this act was paid by the major power companies when the first Feed-in act (StrEG) was implemented in 1991. But when time passed, the large power companies saw that the act could cost them market share in the future. The established power sector tried to obstruct developments of the feed-in act. However, the 'red-green' coalition decided to move the policy forward, and in 2000 a new act (EEG) was adopted. A main difference between the StrEG and EEG acts is the shift from competing with the low and fluctuating market price to remunerating a higher fixed price. The aim of this was to give extra support to investments in renewables (German Renewable Energies Agency, 2010). The current EEG, revised in 2004 and in 2009, is supporting on three pillars:

- First, every energy producer must be able to provide its surplus energy to the national energy grid. Energy from renewable sources has priority above conventional generated energy.
- Energy producers get a guaranteed price for their product that can be financed by a fee on top of the price of conventional energy.
- Financial disappointments in the future do not influence the guaranteed price that energy producers will receive. This minimum price is fixed for 20 years to provide individuals and entrepreneurs some degree of certainty on their investments (German Renewable Energies Agency, 2010).

Overall, initially the costs of energy will rise for German consumers, but this is seen as an investment in the future. However, in 2009 this was only an amount of 35 € per household. When the developments will continue in this speed, it is estimated that Germany could be independent for its electricity of fossil fuels by 2023 (Rakhorst 2010). To reach this objective, in 2010 the German government decided on its energy concept for a long-term strategy to orient the energy system towards RES (BMWi, 2010; Prognos et al., 2010). In 2011, Germany confirmed these targets, while speeding up the phase-out of all nuclear power plants until 2022 (Lehr, Lutz & Edler, 2012).

Both acts didn't directly fund the renewable energy industry, but the way how the three pillars are combined have led to a flourishing new industrial sector. The long term guarantee that the policy will be maintained makes that companies are investigating how techniques can be more efficient and how costs can be reduced. In the act also an attempt is made that investing in different kinds of technology can be cost covering by making technology-specific levels of remuneration (German Renewable Energies Agency, 2010). Following the success stories of companies, and by declining prices due to scale advantages, individual households can make their own considerations if it is cost-efficient for them to generate their own power. In this way, no subsidies are needed to make households and firms switch to green energy, but thanks to the feed-in-tariff, the transition will finance itself.

Nevertheless, some critical voices pointed exactly to the financial issue as a problem. For example the Rheinisch-Westfälische Institut für Wirtschaftsforschung (RWI) has concluded in a study in 2009 that using PV in emission reduction is around 33 times more expensive than the European Union Emission Trading Scheme's market price, while wind power is nearly 2 times more expensive (PV: around 1000 € per tonne of CO_2, Wind: around 50 € per tonne, and ETS: 30 € per tonne) , thereby discouraging other industries from finding more cost-effective methods of reducing emissions (RWI, 2009). In this study it is also discussed the diminution of the German electric utilities capacity to compete in the European energy market due to the diminution of their profits; or the loss of PV market in front of China or Japan despite the German government efforts (RWI, 2009). The response of Germany's Federal Ministry for Environment, Nature Conservation and Nuclear Safety was clear, and he has described the criticism as well known and refuted a long time ago (BMU, 2009).

In fact, according to Hermann Scheer, former Member of Parliament and the initiator of the German feed-in act, the policy will ultimately lead to the 'fourth revolution'. Citizens become independent of the mayor energy companies and from instable regions where the fuels for power plants come from. People become suppliers on their own green energy and therefore are self-sufficient. This was all made possible only by the feed-in act (Scheer, 2009).

To make it even more attractive, some additional extensions of the EEG are being examined, including marketing and making competition with other energy sources more fair (BMWi, 2011).

Mostly, this initiative is an obligated national imposed idea, but the government also stimulates citizens to invest in building renovation themselves. Germans can get financial support when they isolate their buildings before the time set by the government, or when they isolate it better than the minimal requirements. During the years 2009 until 2012, an extra annual amount of 500 million € is invested in supporting households to build renewable energy heat installations (BMWi, 2011).

Viewed at a glance, the German case suggests that a strategic approach to RE development was followed. A closer look reveals that it was not commitment to renewables but the success of policy that carried the country forward to its lead position today (Lipp, 2007).

5.3 Brief conclusions

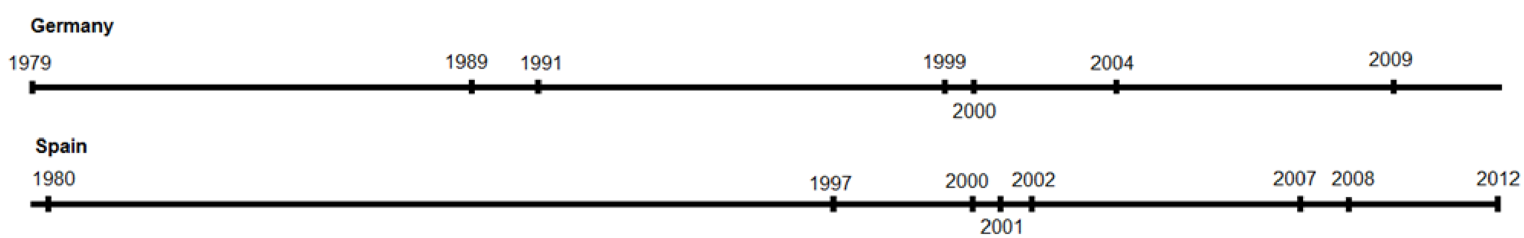
Germany has started, like Spain, in the start of the 80s with the implementation of policies and legislations towards RE and RETs development. Nevertheless, paying attention to Lipp's (2007) words in the former paragraph, the German case suggests that a strategic approach to RE development was followed. In fact, between both institutional movements made in 1989 and 1991, the basis of a flourishing industry and a citizen oriented approach to RE was established in Germany. Some changes were made afterwards (2000, 2004, 2009) but they were mainly updates of the initial legislations and policies, following the path signaled by the first StrEG. Some critical voices have also appeared, mainly pointing at the financial aspect of this RE development, but their comments were refuted by the corresponding ministry. In fact, Germany plans to invest around 200 billion € in RE and RET development in the coming years (Goldman, 2012).

6. Comparison Spain-Germany

In the comparison between German´s and Spain´s way to face the implementation and development of REs and RETs we can find several similarities, but also a few differences. It's possible to outline as the biggest difference the implementation time and as the greatest similarity the use of the feed-in tariff system in both countries. In fact many authors usually show as an example of successful REs and RETs implementation the FIT systems followed by these two countries (Hernandez & Campos, 2011; Ragwitz et al., 2007). We could say that the implementation and use of FIT is the greatest similarity between the paths followed by both countries, but there are also differences in the application of this policy mechanism. In the other hand the biggest difference could be found in the "implementation route". Germany was since the beginning betting for a long-term approach to the REs and RETs, even with government changes in the middle, left or right oriented. Meanwhile Spain had some parts of the RE industry halted for many years and hasn't supported or encouraged it until very few years ago.

Starting with the one previously called the "biggest difference", something that is always sensitive to be doubted or at least argued. In the figure 3 we can see a "time line" elaborated by the author with the main changes in policies and legislation regarding REs and RETs in Spain and Germany.

Fig 3. Time line with the most important policy and legislation changes regarding REs and RETs in both countries



Source: Own elaboration

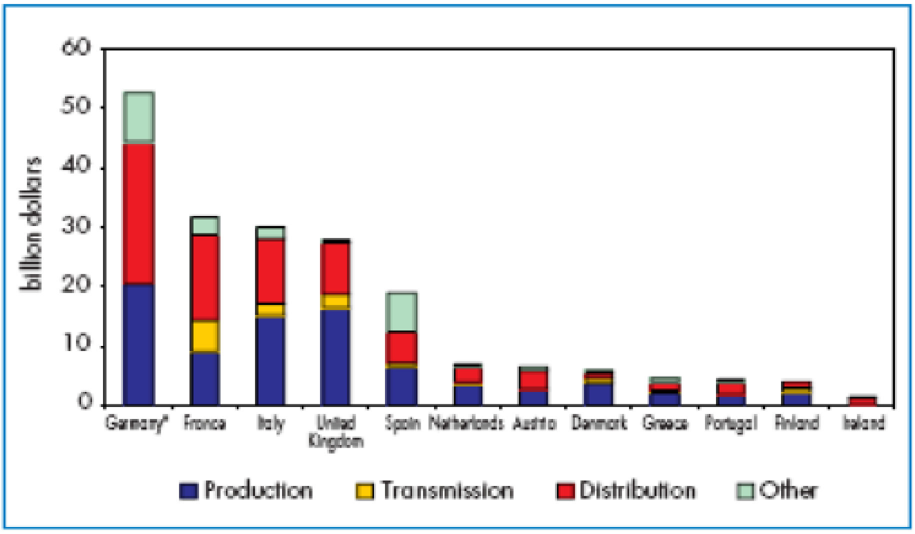
As we can check on the Figure both RE policies and legislations started very close in time, around the early 80s, but in Spain until 1997 the electricity market was not liberalized and the first FIT was not even planned. So, the real start of the RE in Spain can be dated around 1997. With this "real start" concept we refer to the start of other REs and RETs apart from the hydropower, technology which was working pretty well in every EU country since long before. In fact, in this year 1997 Spain was producing double electric energy than Germany with hydropower (Appendix 3, Figure 1), and the comparison of electric energy production through hydropower in both countries the last 20 years was almost always favorable to Spain (Appendix 3, Figure 1).

All the same, though Germany has also started with the implementation of policies and legislations in the same early 80s, in 1989 a really advanced subsidy policy is implemented. This policy is the 1000 roof programme, through which the German government was giving important subsidies to install solar panels in 1000 households (Lauber & Mez, 2004). After two years, in 1991, the German government implements the Electricity feed-in act (StrEG). It was an initiative of some members of parliament aiming for a free access for every producer of power to the electricity grid (Wüstenhagen & Bilharz, 2006). Although very little attention was given to this act in the first instances by the electric and energetic companies, after some time they realize they could lose market share. Nevertheless, not the current government on that time, and not any other government after has gave in to the energy companies pressures. It was probably the most important step, at the same time with the 1000 roof programme, towards the long-term and self-sufficient green electric energy approach. Anyhow, The StrEG was not help enough to compensate the PV costs. In order to preserve the industry, market creation had to come from other quarters. This attempt to mobilize other resources demonstrated the high level of legitimacy solar PV and the renewable energy in general were gaining in Germany (Jacobson &Lauber, 2004). The main helpers on this issue were the solar activist associations and the municipalities (Lauber & Mez, 2004). It was also a very important move because has started to break somehow (or opened a door through which broke it) the lock-in big energy companies had in the country. The discourse and message sent from the government was also clear, first with the 1000 roof programme, and only two years after allowing these people to sell the energy directly in the grid, the energy self-sufficiency will be a possibility someday.

In 1997 Spain started to liberalize the electricity sector through the General Electric Law. This law guaranteed everyone to pay the minimum electricity cost, and allowed also the big consumers (companies, institutional buildings, etc…) to choose electricity provider. The process was culminated in 2003 adding the possibility to choose electricity provider also to the small consumers (households, small business, etc…) (Ruiz, 2003). But the big step was the elaboration and implementation of the first real FIT as policy mechanism to encourage the development of REs and RETs between the years 1997-1998, adding also in 1998 the special regime condition to RES. Spain had already something similar to a FIT implemented in 1994 (Barclay, 2009), but with a not liberalized market and dominated at 90% by Endesa (Ruiz, 2003). Germany had already a FIT since the application of the StrEG (1991) which has encouraged in the following years the wind and solar industry (important to take into account the 1000 roof programme); meanwhile in Spain with the implementation of the FIT (1997) only the wind production suffered an important rise (Appendix 3, Figure 2).

The investment in the electricity sector in both countries was also different during these years. In the Fig. 4 (next page) is possible to compare the investments in the electricity sector in EU countries between 1993 and 1997.

Fig. 4: Electricity Sector investments in EU countries, 1993-1997



* Transmission in Germany is included in distribution.

Source:IEA 2003

As we can appreciate in the Fig. 4 Germany was the leader on investment among all the EU countries, with almost twice investment than the second. Comparing it with Spain the expense was around 150-160% superior. It's not something binding but an important investment of public money or a higher intervention of government in energy sectors, is usually helping in order to prevent lock-ins (del Rio & Unruh, 2006; Cowan & Kline, 1996; Unruh, 2000) The FITs could have also contributed to such big expenses.

In 1999 the electricity market is already fully liberalized in Germany, and another policy is developed to encourage the solar electricity generation and self-sufficiency at household level. Alike in 1989, another roof programme is implemented: the 100000 roof programme. It was a very radical government measure. For instance, it has overcame the recommendation Greenpeace has made to Germany (Documentary: Here comes the Sun, 2008). One year after, in 2000, the Spanish government establish a fixed contract and invoice to fix the conditions of implementation of solar PV, meanwhile in Germany a new energy act was being developed. This new act is the Renewable Energy Act (EEG), replacement of the previous StrEG. The main difference was the establishment of a high fixed price for energy produced by renewables in order to give extra support to investments in RE and RETs (German Renewable Energies Agency, 2010). This act and the characteristics are widely explained above in section 4. The response of the RE industry in Germany to the EEG implementation was clear, and the electric energy produced by solar panels started to grow (Appendix 3, Figure 4). In the other hand, the Royal Decree 1663/2000 in Spain was not producing almost any raise in the solar sector (Appendix 3, Figure 4), although it was not even the objective. This RD was just introducing some regulations in order to make clear the conditions of connection and contract between the producer and the distributor. The RD 1663/2000 was not really trying to encourage the solar panels investments and implementation. In the same year Spain was experiencing the take-off of his GDP, with a growth variation of 4.7% (Appendix 1, Figure 5). At same time the voice of some authors asking for subsidies and promotion to the solar energy sector could be also heard (Contreras et al., 1999; Schweiger et al., 2000). During the next years the Spanish GDP continued experiencing important growth, and meanwhile the government was investing hardly in the construction sector some voices continued asking for investment on RE and RETs and listing the great characteristics of Spanish geographical position (Ridao et al., 2007; Munda & Russi, 2008). Nevertheless the discourses and institutional movements of the government were not really following these ideas, falling in some half-solutions without the desirable outcomes. For example, with the policies and legislations introduced on years 2001 and 2002 which promote subsidies for solar thermal and solar PV installations, and also introduced changes in the special regime energy production, practically no effect was appreciated in the growth of these technologies (Appendix 3, Figure 4; Appendix 3, Figure 6), neither in biomass (Appendix 3, Figure 5).

On the other hand the wind industry continued its rapid growth, because at least this RE industry was successful from the deployment point of view. Since the implementation of the previously commented Law of the electricity sector (1997), the appearance of the special regime production in 1998 and some other promotion plans established in 1999 (Promotion of the renewable energy) and 2002 (changes in special regime conditions) the wind energy sector experienced an important take-off, culminated in 2010 producing more electricity through windmills than Germany (Appendix 3, Figure 2). These previously commented laws and regulations have provided important incentives, stability and certainty about the government's promotion framework. Nevertheless, the sector asked for a long-term guaranteed price, like Germany had (del Rio & Unruh, 2005).

In 2004 the German government revised the EEG. This modification reduced the on-shore wind rates and excluded the low zones for new windmill farms, but improved the rates for off-shore wind. It introduced also important incentives to biomass with additional advantages for new technologies. The most important change was probably an important increment on the PV rates, making them commercially attractive without any other extra support (Lauber & Mez, 2004). It's important to outline that it was not only in Spain where politicians and institutions seem to be sometimes acting following underlying interests, as previously mentioned Flyvbjerg´s or ex-president Eisenhower´s speech words reflect. In fact, the first draft of this modified EEG led to a conflict with the Economic Affairs minister Clement. He attacked the very principle of the feed-in tariff and argued that wind rates were excessive. The development of the EEG continued against the preferences of Clemet, but he was successful obtaining reductions in the rates of wind and defending coal interests (Lauber & Mez, 2004).

Nevertheless, is also interesting to emphasize that Clement was a long-time politician from coal state North Rhine-Westphalia. So, what interests was he defending? Probably he was defending the interests of "his people" from North Rhine-Westphalia and not the interests of any coal company. Here we have again a strong socio-institutional inertia between the German government trying to go further in the RE industry and this coal state anchored somehow in the past, which might has entered in an important economic and social depression if his interests were not defended by Clement. This situation was very similar to the one commented as example of socio-institutional inertia in section 3, what is happening nowadays with the coal in Spain. The solution to these very complex problems is never easy to find, but it would lie in a long-term approach industry reconversion taking into account the social capital available and trying to avoid any functional or cognitive lock-in carried by, in this case, the coal industry to continue receiving subsidies hide behind the social problems (Harmaakorpi, 2004).

In 2007 a new Spanish government designs and implements a brand new and very attractive FIT in order to really activate the Spanish solar market and lure international investors. This new FIT model was much more similar to the German type than any other of the previous ones, but had still some differences. In fact, the FIT could be considered as the biggest similarity between the two models. The FIT model was also considered as the most effective system applied to promote REs and RETs development, following the European Commission advice in its 2005 communication COM (2005) 627. Nevertheless, some authors like Wang (2009) were advising about the risks that this kind of promotion embraces. Taking a look to the Figure 4 in Appendix 3, we can notice an important growth on the growing rate of electricity produced by solar PV between years 2007-2008. But at the same time is possible to realize another important decrease in this growing rate only 1 year after, between 2008 and 2009. It was produced mainly by a policy implementation mistake. Spain wanted to lure the investors very fast, so the government approved in this 2007 royal decree a very attractive FITs for solar PV.

Fig. 5: Spanish feed-in rates from 2007 until 2012 (stop of subsidies for new projects)

	FIT (€-cents/kWh)	Duration (years)	Annual degression (% in FIT reduction)
Hydro	7.8	25	0
Biomass	6.5-15.89	15	0
Geothermal	10.29-26.72	20	0
Wind (on-shore)	7.3	20	0
Wind (off-shore)	7.3	20	0
Solar PV (Until 2008)	22.93-44.0381	25	0
Solar PV (2008-2012)	31.2-34	25	0

Source: Ministerio de Industria, Turismo y Comercio, 2007

The 2007 FIT caused, in words of John Woolard, CEO of Bright Source Energy in Oakland, California, a "gold rush" regarding solar PV investments in Spain (Wang, 2009). Actually, Spain experienced an increase of 482% in solar PV installed capacity in 2007, stimulated by this very favorable FITs (Renewable Energy Corporation ASA, 2009). Nevertheless, the installed capacity was at the end of 2008 ten times more than the expected in the period 2005-2010 (KPMG, 2009). This huge increment of the installed solar PV capacity was somehow lured by the government indecision. In September 2007, Spanish government realized that the CAP of 400MW predicted until 2010 was already in 344MW. In this moment they had to decide if raise the cap and adjust the rates, and they did. The cap was raised until 500MW for 2009 and the FIT was changed in the RD 1578/2008. This movement that looks like a good idea caused the rush in the building of every solar PV project in order to get the old FIT conditions, more than one GW was installed in 2008 alone (Wang, 2009).

The main problem related with this event is the loss of confidence of the investors in the Spanish solar energy market. As it was stated by Woolard "You have to have the confidence that whoever is backing the feed-in tariff wouldn't change the rules on you". In fact, Spain moved from being the first investment market in the solar PV industry in 2008 (KPMG, 2009), to be even out of the top ten in 2009 (Wang, 2009). Due to this change of rules some projects become not fundable or even a loss of money for the owners.

The use of an annual degression, or decreasing feed-in tariff could have been a solution to balance the attractiveness of this policy. It was suggested in 2005 by del Rio & Unruh as a step in the good direction to take into account in the subsidies and rates the influence of the advance through the learning curve and the learning effects, which cause important reduction in implementation costs. The annual degression was, for example, already present in the German feed-in rates in 2006.

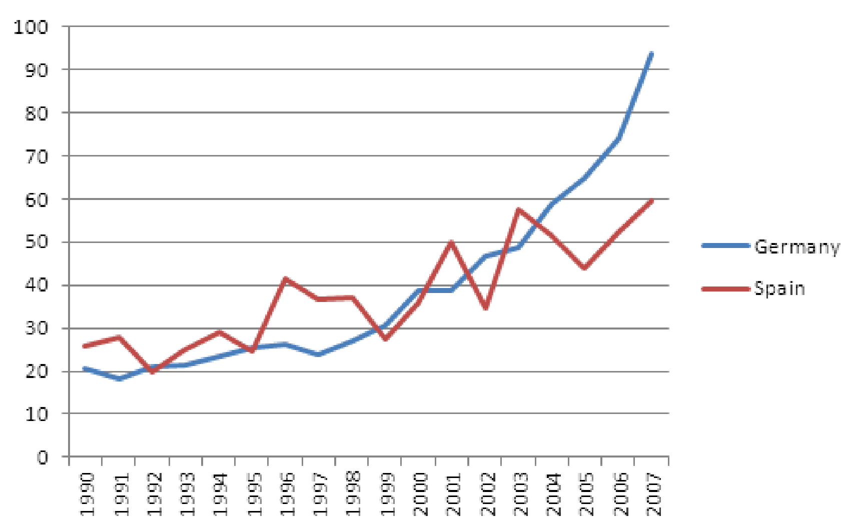
Fig. 6: German feed-in rates under RESA, 2006

	FIT (€-cents/kWh)	Duration (years)	Annual degression (% in FIT reduction)
Hydro	6.65-9.67	30	0
Biomass	8.15-21.16	20	1.5
Geothermal	7.16-15.00	20	1.0
Wind (on-shore)	5.28-8.36	20	2.0
Wind (off-shore)	6.19-9.10	20	2.0
Solar PV	40.6-56.80	20	5.0-6.5

Source: DENA, 2006

Paying attention to the German FITs we can notice how the solar PV FIT was even higher than the Spanish one, but due to the annual degression, in just seven years the €-cents/KWh paid in Germany were less than in Spain. This issue carries us again to the importance of a long-term approach to a complex sector like the electric energy field. In the Fig. 7 we can appreciate the evolution of the quantity of electric energy produced by renewables in both countries.

Fig. 7: Electricity generation by renewables (TWh)



Source: European commission, 2010.

Ivan Golpe Diaz
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The craggy aspect of the Spain line is mainly characterized because of the important contribution to the global electricity produced by renewables of the hydropower, which is very unequal along the years (Appendix 3, Figure 1). However, the trend is going up, because the rest of the RES are much more stable in the production and growing. The relatively soft going up of the German curve is a reflect of his long-term approach, not very fast in the beginning, but continuous and very diversified, in which no one of REs or RETs has a main role in the energy production, it is more balanced. The influence of the heat and electricity produced by biomass has also a big incidence on this graph. In 2007 Germany was producing around 22000 TOEs of heat and electricity through biomass, meanwhile Spain was around 5000 TOEs in the same period. Also in the same year 2007, the important change in the FITs commented above with the RD 661/2007 introduced some changes in the development of biomass in Spain. Nonetheless only a tepid rise was produced (Appendix 3, Figure 5), because the legislation and policies applied lagged behind the expectations elaborated in the Renewable Energies Plan (PER) 2005-2010 (IDAE, 2005).

Another revision of the EEG is carried out in Germany on year 2009. This revision is reinforcing some key points for the further development of the RE sector in the country. One of these key points is the off-shore wind, improving the implementation conditions and the grid connection, as Germany was already putting big hopes in the offshore wind electric energy generation. The general grid structure is also improved for every installation of RES generating electricity, and the FIT is revised too (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2010).

Three years later, in January 2012, the new party in the Spanish government announces the halt of any subsidy for any kind of RES. This decision is inside a package of very hard cuts in all the budgets in the Spanish state, but is it still a reasonable decision? Paying attention again to Obama´s words, and taking into account the position of every US president regarding fossil fuel policies, was still not clear the importance of RE industry for the Spanish government? Was it really needed to cut so drastically the budget of RES? As it was stated before, the global discourses and macro-level trends are changing regarding RE and RETs, also the national and international agencies were, and are outlining the importance of continue developing the industry of RE in order to achieve the environmental, security and industrial objectives.

For instance, the international Energy Agency stated in the Spain 2009 review "As renewable energy is not an end in itself, but a means for reaching the broader energy policy goals of economic growth, environmental protection and security of energy supplies, the cost and benefits of promoting it should be seen in a broad perspective. To ensure the overall cost-effectiveness of its energy policy, the government should continue to support renewable energy, but at the same time vigorously encourage energy efficiency improvements that often bring the same environmental and energy security benefits at a lower price" (IEA, 2009)

Whereas, Spanish government seems to be turning a deaf ear not following any of these recommendations, being only worried in search a solution to the current economic problems in the budget cuts, when a continued investment in RE (maybe not a big one, but a continuous one) would provide much bigger economic benefits in the future. There are not few articles and publications about the capabilities of a zero-emissions electric model in Spain with not so big effort and investment. Just to mention some of them, we have a paper from the Global Energy Network Institute elaborated in 2011 which says that with the right investments and legislation processes Spain could reach 100% electric energy by renewables in 2020. There is also another report called A New Energy Model for Spain, recommendations for sustainable future, published in 2009 by the Fundacion Ideas, in which is stated that Spain can easily reach 100% electric energy by RES. A date is not set in this report, but some key points are analyzed. For example, they support that the jobs created with this model would range from 282.531 to 1.188.781, the cost of the transition would range from 102.401 to 347.543 million € and because of the development of the technology and the energetic surplus Spain would have access to a potential global market of between 2.06 to 8.09 billion €. And we can also find a paper of Greenpeace called Renewables 2050, a report on the potential of renewable energies in peninsular Spain, in which they assure in 2050 Spain could produce 56,42 times more electric energy than the expected demand for this year, only with RES.

This type of reports and projects are many times just something to dream about, but as it was stated before Germany has overcame the suggestion of solar PV capacity of Greenpeace not so long ago. In fact, meanwhile in Spain the RE and RETs are halted of subsidies and government investments, German´s Chancellor Angela Merkel has announced an investment of 200 billion € in renewable green energy sources. The cost of this programme is 8% of Germany´s 2011 GDP (Goldman, 2012).

These are the kind of politic and institutional movements that make changes in the macro-level and arise the social and economical support for RE and RET. Actually, the single reason normally pointed as the success of German RE industry is the appropriate us of the FIT, but other factors were also present enabling the RE diffusion and implementation, like the rise of an important civil support to REs and RETs, allowing this model to survive to three changes of government (Krazat, 2006; Schurig, 2006).

Despite the appearance of some critical voices, between which we can stress the previously commented RWI's 2009 study, the German approach towards RE seems to have wide support. It has also been pretty successful in the obtaining of the usually expected objectives related with the RE and RET development (protect the planet, strength the energetic security and create a flourish industry) (Rakhorst, 2010; Lipp, 2007). By opposition, Spain has invested little money in the electricity sector during the end of the XX century (IEA, 2003) and a wide social support towards renewables has not been reached yet (IEA, 2009). Nevertheless, not everything is so black or white, the bigger investment made by Germany had also associated a bigger risk. For example, in the RWI 2009 study has stressed that the use of PV to reduce emissions is 53 times more expensive than the European Union Emission Trading Scheme's market price, or the loss of PV market share in front of China or Japan. However, a new try to summarize and schematize the main differences emerged from this comparison will be carried out in the table below (next page).

Table 4: Main differences Spain-Germany towards RE approach

Germany	**Spain**
- Regressive FIT. - Early liberalization of electric sector. - Strategic long-term approach. - Continuous investment and support from the government, independent of the ideology. - Promoting competition between citizens and electric energy companies. - Important measures oriented to the citizen. - Firm idea to become independent of fossil fuels in electricity generation in the next decade (200 billion € investment).	- Fixed FIT. - Late liberalization of electric sector. - Initial passivity and belated diversification of RET. Dramatic solar PV short-term approach. - Different institutional movements, legislations and economical support depending on the political party on power. - Citizen mainly out of the electric generation market. - Most of the measures oriented to preexisting electric companies. - Halt of FIT and subsidies for any new RE project due to economic crises.

Source: Own elaboration.

Ivan Golpe Diaz
s2145324

Ivan Golpe Diaz
s2145324

7. Conclusions and Advices

7.1 Conclusions and Advices

The conclusions of this kind of research are many times, in some way, dependent of the scope and vision of the writer. The idea followed throughout this research was to base as much comments, opinions and statements as possible in numerical data and statistics, most of the times obtained from the European, Spanish or German official databases. In other cases, when this kind of data is not available the trend was to follow academic articles, PhD researches, websites and all kind of contrasted information. However, although it has been done, the personal opinion on the issue and the concepts and ideas developed in the mind after all the information consulted will inevitably sharp the conclusions, and even more, the advices. Hence, in some degree the outcomes, and mainly the advices of this research could be very arguable or very agreed depending on the vision and previous opinions of the reader. Anyhow, these conclusions and advices will follow as much as possible the logic developed throughout the research and will be also supported by references to other articles that have thought about them before.

After the comparison between the Spanish and the German case, some interesting conclusions emerged. Some of those conclusions were clearly evident since practically the beginning of this research, but some others surged from unexpected horizons.

The first conclusion and probably the most unexpected one is the very intrinsic relation some factors have at macro-level, influencing the RE and RET development. How the discourse emitted from the government and the legislation and policies emerged from the institutions can sharp the social interaction and change the social values regarding RES. Both of them result at the end of the research being pressing each other. For example, the government follows a discourse to develop RES, and implement favorable legislation and policies to do it. The citizens being benefitted by this policies and rules, feeling the possibility to produce part of their own energy while saving some harm to the environment, change their social values. Otherwise, when a certain point is reached (what has happened in Germany) the social values related with the RES and the natural environment protection come to a degree in which they almost “force” any new government to continue through this trend, being left or right wing oriented (Krazat, 2006; Schurig, 2006). How to reach that “certain point”? That’s not really clear, but it really looks like coming from this macro-level interaction, shaping the right discourses and promoting the right institutional movements to favor the average citizen, and making them prone to this trend.

Spain, somehow, has followed the German path in some important principles regarding the REs and RETs development and implementation, and is also much better located geographically, but this point was not reached, why? Paying attention to the previous sections, something could be discerned. None of the Spanish governments took radical decisions towards RE policies. Coming from the start, the 1000 roof programme combined with the StrEG carried the German government to the constitutional court versus Preussen Elektra (now e-on) in 1998 (Lauber&Mez, 2004). The 1000 roof programme was not as successful as German government thought, but the "certain point" was already reached and when the notice was made public, the solar activists and the municipalities supported it. Afterwards again, with the 100000 roof programme Germany overcame the suggestion of Greenpeace installing solar panels. And nowadays is again happening, according to Goldman (2012) the projected investment of 200 billion euro in renewables next years by the German government is a big risk again "…if however it fails it will be a disaster for the German economy and the society." (Goldman, 2012).

Whereas in Spain mainly just tepid movements were made in order to promote RES. However, is important to outline the legislation changes in 1998, 1999 and 2000 to promote wind, what have worked really well. But they were addressed to the big energetic companies, not to the average citizen. In this way the social values cannot be changed so fast, the citizen is not getting any palpable benefit. The citizen was excluded of the macro-level equation commented above, the government favor the wind, so big companies can produce "green energy", the natural environment is less harmed, and you can buy it but at same price than before, but with the same possibilities to become energetically self-sufficient than before, practically none.

This problem carry us to a conclusion: need for greater societal implication, more measures oriented to the citizen, and a change in the discourse towards self-sufficiency, even going against the big electric and energetic companies. Or, is it not possible in Spain? Here the tricky terrain of rationality of power and second political interests is again over the table. It is possible the Spanish government didn't notice the importance of the societal implication, and preferred to encourage the big electric companies role in the RE development. Although is also possible that trying to avoid trouble with the energetic corporations, they simply prefer to support the big companies. They could do it quite easy, just shaping the discourses on that direction. Nowadays, it is not really possible to blame them, because they simply chose a different way. Suspicious thoughts can cross your mind based on Flyvbjerg (1999) and Hajer (2005) theories, but the underlying reasons of those decisions, if there ever was one, can very difficult be proved.

However, are there only these two possibilities? The third possibility and likely the right one is the influence on the discourses and political decisions by the path dependency and socio-institutional inertia. "In fact, although it is fairly easy to identify allocations, technologies, or institutions that are path dependent in some form, it is very difficult to establish the theoretical case or empirical grounding for path-dependent inefficiency." (Liebowitz & Margolis, 1999). Therefore, if it's very difficult to define the problem, it will also be very difficult to find the extent of its influence.

These phenomena appear in this study as the "hand in the shadows" influencing the macro-level from the meso-level. It carries us to an already expected outcome of the research: the meso-level is the one presenting more trouble to the implementation of RE and RETs. However, the expected result is that the pressure brought by the macro and micro levels will at last, more or less drastically, defeat the resistance. Nevertheless, it is also important to stress that for example the levels of resistance regarding meso-level influence on the macro-level are quite different between Spain and Germany. These radical decisions taken by Germany commented before were permitted by a lower pressure, or more likely the pressure was broken by these decisions.

One more possibility should be highlighted, the cultural differences. It was argued since the beginning that the main focus of this research would be limited to the policies, legislations and institutional movements of both countries towards RE and RETs, but was also argued the influence the ethnology could have shaping them. Therefore, though the scope regarding this factor is pretty limited in this research it's important to stress ethnology's importance. In fact, the cultural differences between Spain and Germany might be an insuperable gap trying to apply similar policies and legislations, in search of successful RE and RETs deployment.

Secondly, another important point was to realize the capital importance the long-term approach has in support continuous investments in REs and RETs. This long-term approach creates confidence in the investors and they are more prone to trust and invest capital in projects inside the country. If it cannot be reached through the societal pressure as was commented before and is the preferable way, the different political parties, independent of their ideologies, should make an agreement on continue promoting the RE in every condition recognizing in this way the capital importance of the sector. This long-time approach has to be supported from the institutions with policies and legislations. Not just in the discourse, also promoting continuous incentives and investment of public money in the electricity sector.

Furthermore, the programmes addressed to the average citizens, to "green up" their households or businesses have to be oriented as an investment which could make profit, or at least afford some money in short or medium term. The 2001 and 2002 Spanish policies to encourage the installation of solar PV and solar thermal on households and small business, as was commented above, had not at all the desirable effects. It has promoted a bit the solar thermal expansion, but has not almost affected to the solar PV development. On the other hand, a policy introduced in 2006 setting as mandatory the installation of solar PV or solar thermal in every new building constructed in the Spanish territory (Documento basico HE, 2006) has worked positively (Appendix 3, Figure 4; Appendix 3, Figure 6). It wasn't again oriented to the citizen as a profitable future investment, it was addressed as an obligation but it was a smart movement taking into account the huge volume of the construction sector on these years in Spain.

The failure of the first commented aids to solar PV were previously highlighted and commented by some authors. They identified several important barriers to the development and implementation: There was a lack of precision in the legal framework and not always sufficient support. In those times, before 2007, the FIT in Spain was considerably lower than other EU countries. The government was providing the soft loans, and the subsidies were coming from the regional authorities. These subsidies could vary from 15% to 50% depending on the region (Greenpeace, 2003). The procedures and bureaucracy were often complex and cumbersome to get the permissions and the subsidies (Greenpeace, 2003). Besides, the Spanish solar PV association (ASIF) was claiming that conventional electric utilities saw solar PV as a threat and were creating barriers taking advantage of their dominant position (lock-ins). In fact, "most PV generators have a medium voltage grid connection and are obliged to install a transformer, substantially raising the cost of the PV installation. Investments in grid reinforcement further discourage PV projects. Generators claim that grid access continues to be discriminatory and at unfair fees and directly accuse the grid operator and utilities of preventing PV access." (del Rio & Unruh, 2005).

The former paragraph carry us to the third conclusion, the urgent need to simplify the bureaucratic procedures. The barriers are present not only at permission procedures level, they are also at bureaucratic and administrative level due to the different government layers present in Spain. The creation of a unique contract with some fixed procedures and valid for every government layer would be a big step forward.

In the last published IEA review about Spain in year 2009, it was mentioned the important work that remains to be done in the non-economic barriers. In this category the report was including the administrative hurdles, the obstacles to the grid access, the lack of information and the social acceptance issues. The first two of them were already commented above, and the last ones, as was argued in the start of the section, are highly dependent on the institutions and the discourses. Therefore, keeping ourselves inside the limits of the institutions, legislations and policies set in the start of this research some recommendations will be made.

Regarding the information issue, a change in the discourse would have a direct impact. The discourses emitted by the governors and the different institutions are reaching almost the totality of the country population, being it by media or afterwards by social interaction. A movement towards environmental protection and RE importance, supported of course by policies and favorable legislation could produce the desired outcomes. It will also foster the social acceptance of these technologies, but in order to get a strong one, other more specific measures should be implemented. For example reducing the bills to the people who are living very close to windmills or solar panels farms, and rising it to the people in the communities were almost no RE is produced. Furthermore, as it was commented above, the implication of the citizens with direct subsidies and programmes to encourage them to be energetic self-sufficient, or at least to have this idea in a plausible horizon.

Nevertheless, the presence of the crisis is indeed projecting a long shadow over the heads of our governors and institutions, causing the lack of funds to develop or carry on many of these advices. However, with some smart and brave movements towards the development of the RE industry and applying the idea of "make the pollutant pay" some budget funds can be recollected. For example externalize the costs of the traditional energy sources through indirect taxes in the production, or raise the direct tax in the implementation of any new electric energy project which is not using renewable sources.

Projecting a wise use of this funds, planning a slow but long-term approach towards incrementing the share on renewable, implying the society with the policies and emitting favorable legislation from the institutions there is still a light at the end of the tunnel for the RE industry in Spain.

7.2 Analysis of outcomes and reflections

Taking a look back, the conclusions and ideas emerged out of this explanatory study (Yin, 1984) sound logical and somehow quite close to the ones mentioned in such important studies about transitions like “Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework” (Loorbach, 2010) or “More Evolution than Revolution: Transition Management in Public Policy” (Rotmans et al., 2001). It was not the aim of this paper design a transition or talk directly about them; in fact the word “transition” was avoided as long as possible throughout the work. The reason for that was to prevent any comparison between this work and the design of a transition. The latest regarding such a big country like Spain, and a highly complex field like electric energy generation exceed the time and scope of a master thesis work like the one present here. However, it´s important to outline some similarities in the basic characteristic of the “transition process” mentioned by Loorbach (2010) and Rotmans et al. (2001) and the findings emerged in the conclusions of this thesis paper.

Being much broader the scope of both articles previously mentioned regarding structural changes in complex systems, we can still outline three important similarities with the findings of this thesis. The first one, and likely the most significant, is the importance of the societal implication. Without being one of the main focus points of this research, the societal acceptance and implication factor was revealed from the institutional, political and legal standpoint as probably the capital one. Inside Rotmans´ (2001) and Loorbach´s (2010) articles the societal factor plays also one of the main roles, arguing also in favor of a bottom-up change, instead of the classical top-down approach (useless in these highly complex systems).

Another common characteristic is the multi-level approach. Rotmans and Loorbach talk in their articles about different aggregation levels. These levels are not even coincident, but both of them state clearly the importance on distinguish these levels, and analyze the behaviors of the actors within the different levels. In this work, the first sign about the possible usefulness on apply a multi-level approach appeared in the time when the sub-study about the opposing factors to the deployment of REs and RETs was carried out. It was quite clear that the opposing factors, and also the path dependency and socio-institutional inertia, have their roots in the same aggregation level. Taking definitively the model and characteristics extracted from Rip & Kemp (1998) and Rotmans et al. (2001) the division in macro-, meso- and micro-level fitted quite well, keeping divided the current opposing and the in favor factors.

The last common characteristic, and also a capital one together with the social acceptance and implication, is the long-term approach. The importance of a long-term approach in investment and support from the institutions and policies was one of the expected outcomes emerged from the comparison between the German and Spanish RE deployment. In both Rotmans´ and Loorbach´s papers the long-term approach is mentioned as one of the basic characteristic of a successful transition. In fact in this thesis is analyzed the opposite approach in a sub-field inside the RE industry, a relatively short-term approach applied by Spain in order to rapidly expand the PV solar industry. This attempt had not the expected outcomes, and didn't found a good basis for the later deployment of the PV industry in Spain and consequently not for a hypothetic transition either.

Taking into account these findings regarding the historical development and implementation of REs and RETs, it seems logical to state that Germany was somehow applying the most logical principles of "transition management" even before the appearance of the term in the sense we know it today. It is maybe a big statement, but it is undeniable that throughout the history, lots of transitions were carried out before the appearance of the theory able to explain them. One of the clearest examples could be the "transition" from the stagecoach to the train as the main transport system in America during the XIX century. Nevertheless, another transition appeared in the transport systems during the XX century, there was a bigger diversification, but the car and the plane overcame the train in practically every kind of trip in America.

Paying attention to this last idea would be a bit naïve to think that the RE and the RETs are the very last stage in the electric energy generation developed by the human race, wouldn´t it? Another important energy transitions occurred in the past, although not an important electric energy transition yet. It is because the electricity is something relatively recent, and the step coming nowadays in the field is a big one, being able to produce energy forever without resource consumption. However, technology is developing faster and faster, and nobody can guarantee that in 100 or 200 years the RE will not find insurmountable constrains.

When the time comes, someone could be making an explanatory work like the one present in this thesis, trying to throw some light on the difficult and slow steps from the RE to a new and much more efficient energy generation technology. The deployment of this "new and better technology" will probably find similar constraints like the RE found and is still finding nowadays. The path dependency brought by the whole infrastructure needed to produce the biggest share of the energy by RE might be even bigger than the one we are suffering now related with the coal or gas. Huge windmill parks and solar panel farms (onshore and offshore, both of them) spread all along the different countries will provide a really important path dependency and will be a big hindrance in the development of this hypothetic transition. Furthermore, social contracts, policies and legislation, underlying agreements and all kind of concessions made in the past towards the deployment of RE will create also a huge socio-institutional inertia against the development and implementation of the "new and better technology". This situation will likely trigger the development of a significant lock-in towards RETs. Policies and legislation, economic factors, credit facilities or industrial processes would be hardly influenced by this lock-in, preventing as long as possible the success of this hypothetic transition.

Supposing that societal structures and politics had not suffered a deep change by that time, the words of Madeley (1999) will probably continue being highly topical. Madeley (1999) argues about the continuous loss of power of the different national and international governments in favor of the big corporations. Accepting this statement for our hypothetic future, maybe the RE companies on that time would represent something like the oil companies are today (very criticized in different society spheres). Hence, their capacity to influent the different decisions taking at the political, legal or economical level would not be negligible. Here appears again the rationality of power and the capacity to somehow shape the mainstream discourses, trying to orient the path of the energy sector in their direction, as long as possible

These last two paragraphs are just pipe dream, indeed, but is an attempt to justify in an elegant manner the chosen theoretical framework to carry out this work. The idea was to show the usefulness of the "tools" I have chosen to research and analyze the electric energy sector and his development in Spain and Germany. It is possible that maybe better "tools" could be used, or another standpoint could have been wiser; but the usefulness of the ones applied in this work is evidenced since it is possible to apply them to a logical hypothetic similar future situation, and of course, to many other past noteworthy "transitions".

Ivan Golpe Diaz
s2145324

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Ivan Golpe Diaz
s2145324

9. Appendix 1

Figure 1: Gross electricity generation from PV solar panels between 1990 and 2007

European Commission
Directorate-General for Energy and Transport (DG TREN)

Gross Electricity Generation from Renewables *
Photo voltaic (in GWh)

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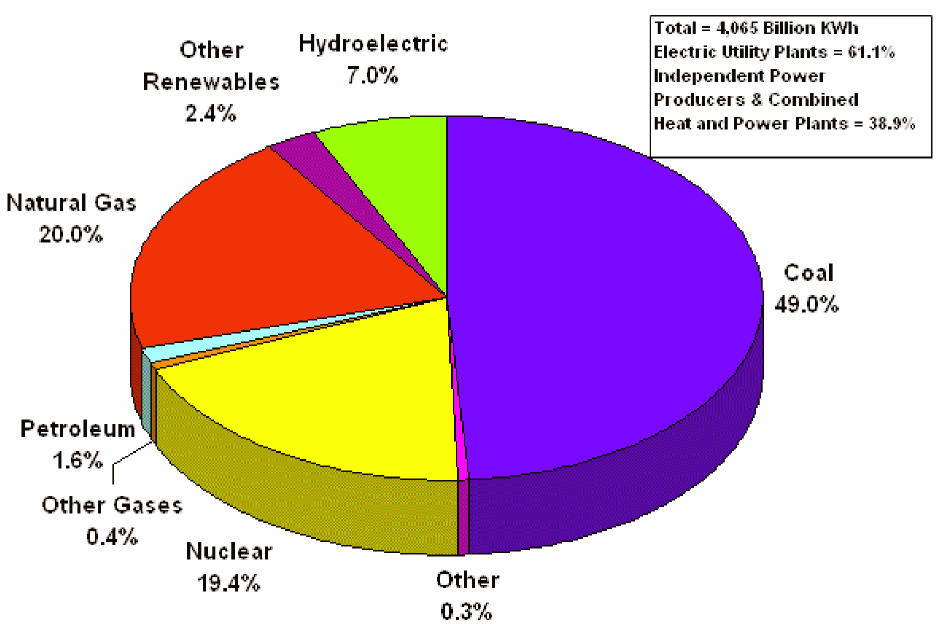
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007		
EU27	5	7	13	18	23	26	33	41	62	76	117	192	280	459	720	1 450	2 488	3 758	EU27	
EU25	5	7	13	18	23	26	33	41	62	76	117	192	280	459	720	1 450	2 488	3 758	EU25	
BE															1	1	2	6	BE	Belgium
BG																			BG	Bulgaria
CZ																	1	2	CZ	Czech Republic
DK										1	1	1	1	2	2	2	2	2	DK	Denmark
DE	1	1	3	3	7	7	12	17	35	30	60	116	188	333	557	1 282	2 220	3 075	DE	Germany
EE																			EE	Estonia
IE																			IE	Ireland
EL															1	1	1	1	EL	Greece
ES				1	2	3	3	3	4	17	18	24	30	41	56	41	125	501	ES	Spain
FR											5	6	7	7	8	10	12	17	FR	France
IT	4	5	9	11	11	13	14	15	16	17	18	19	21	24	29	31	35	39	IT	Italy
CY														1	1	1	1	2	CY	Cyprus
LV																			LV	Latvia
LT																			LT	Lithuania
LU												1	1	1	9	18	21	21	LU	Luxembourg
HU																			HU	Hungary
MT																			MT	Malta
NL				1	1	1	1	2	3	6	8	14	17	31	33	34	35	36	NL	Netherlands
AT				1	1	1	1	2	2	2	3	4	7	11	14	15	15	17	AT	Austria
PL																			PL	Poland
PT							1	1	1	1	1	1	2	3	3	3	5	24	PT	Portugal
RO																			RO	Romania
SI																			SI	Slovenia
SK																			SK	Slovak Republic
FI		1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	4	FI	Finland
SE												1							SE	Sweden
UK										1	1	3	4	3	4	8	10	11	UK	United Kingdom
HR																			HR	Croatia
MK																			MK	Former Yugoslav Republic of Macedonia
TR																			TR	Turkey
IS																			IS	Iceland
NO									3										NO	Norway
CH	1	2	3	4	5	5	6	8	8	9	11	12	14	17	17	19	23	27	CH	Switzerland

Source: Eurostat, May 2009

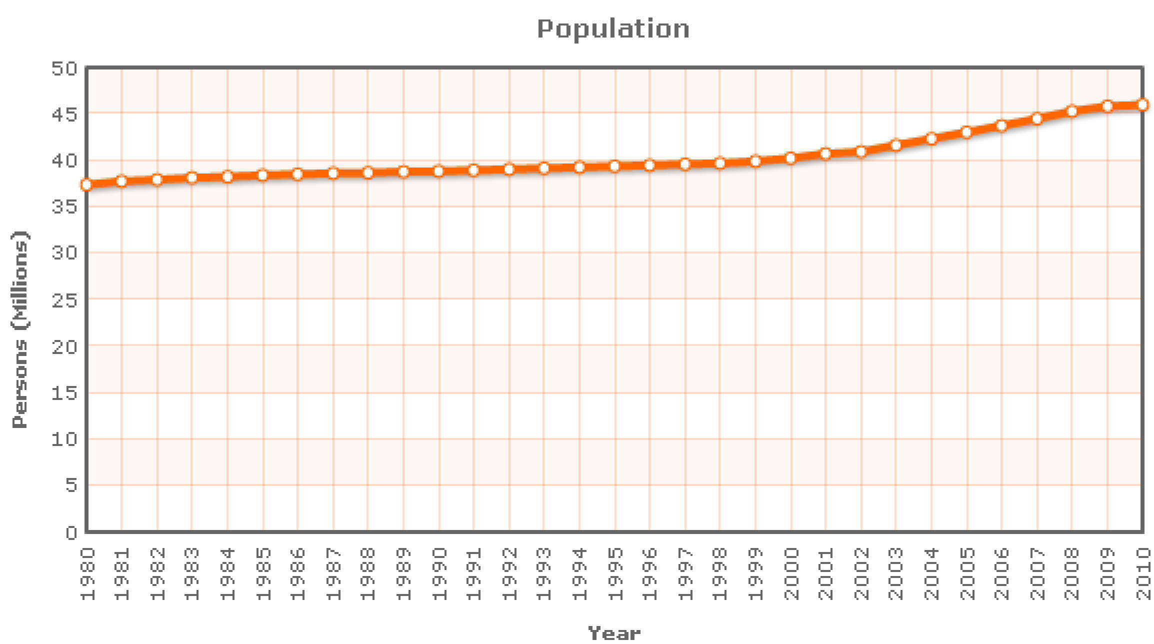
Source: European commission, 2010

Figure 2: Share of electric energy generation USA, 2006



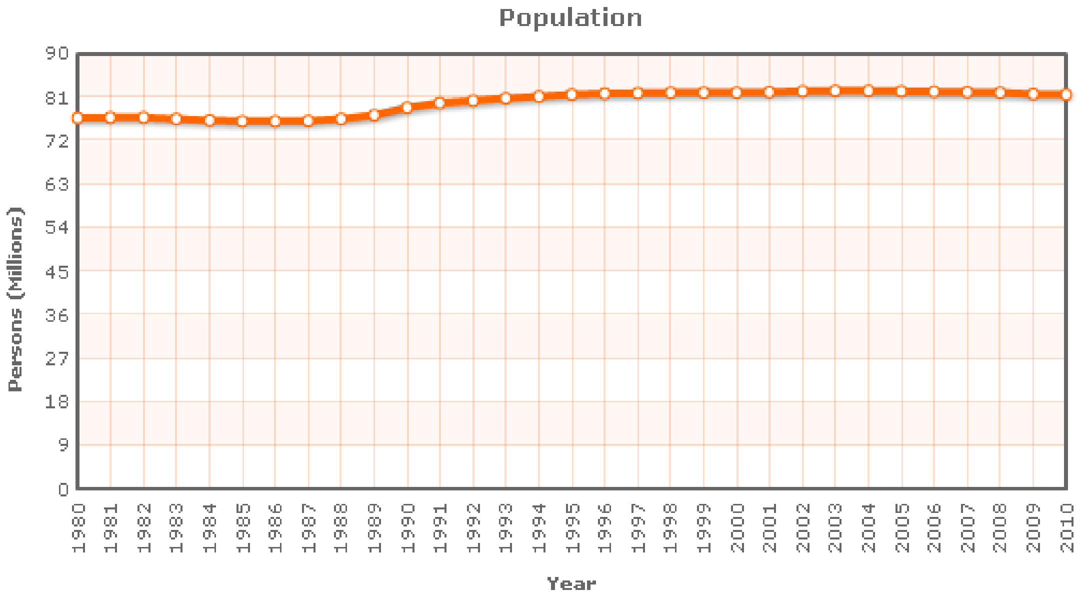
Source: EIA, 2009

Figure 3: Population Spain from 1980 to 2010



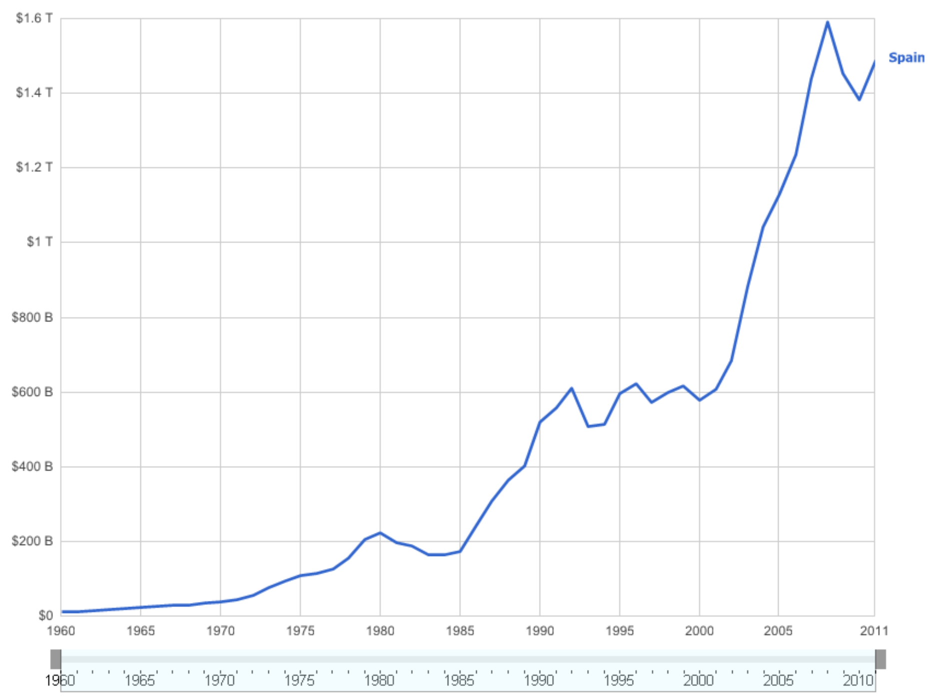
Source: International monetary fund, 2011 world economic outlook.

Figure 4: Population Germany from 1980 to 2010



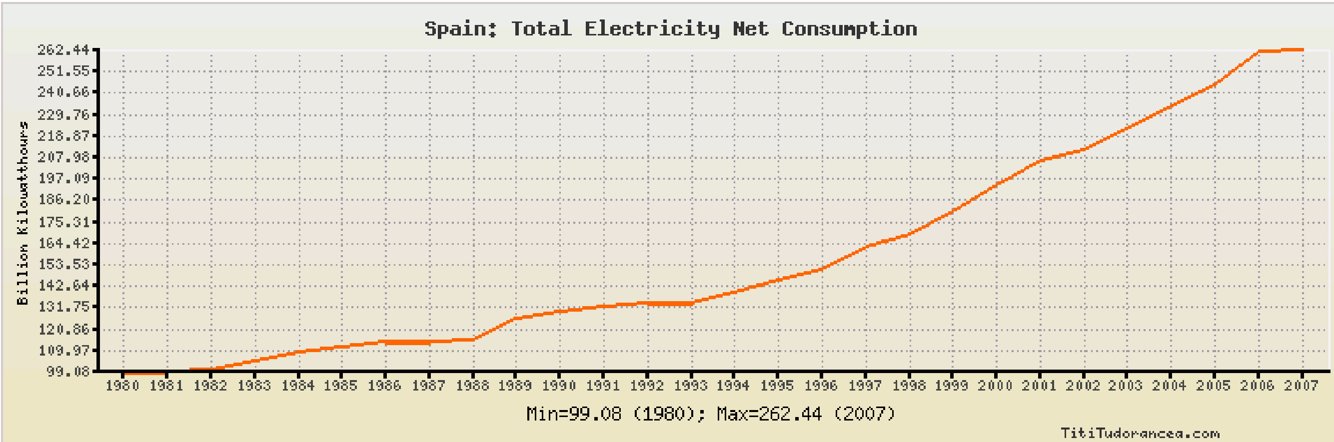
Source: International monetary fund, 2011 world economic outlook.

Figure 5: GDP Spain between 1960 and 2011



Source: World Bank, 2012. Availabeonline at:http://www.google.com/publicdata/explore?ds=d5bncppjof8f9_&met_y=ny_gdp_mktp_cd&idim=country:ESP&dl=en&hl=en&q=gross+domestic+product+spain

Figure 6: Electricity consumption in Spain between 1980-2007

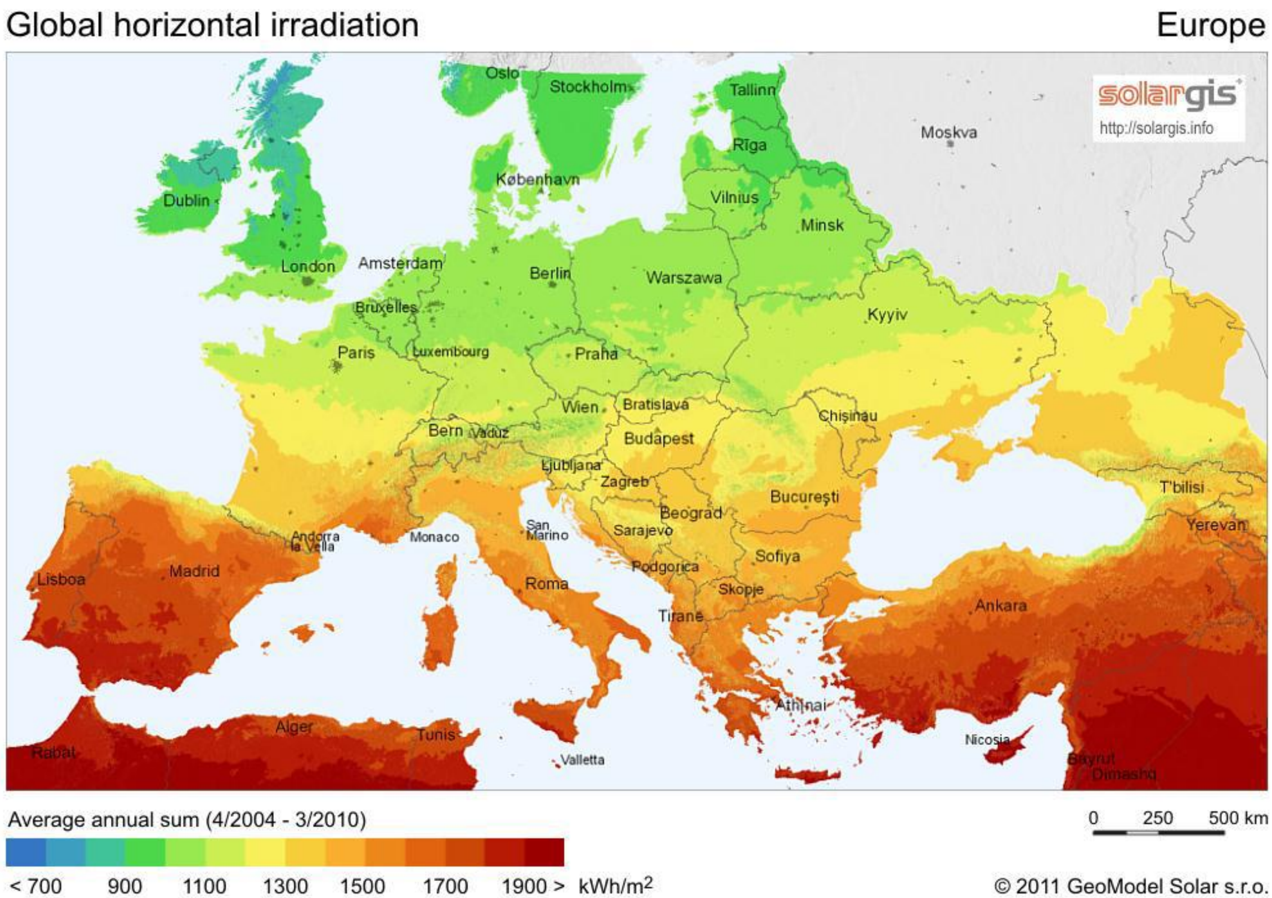


Year	Spain	Change, percent	Spain, percent of Europe	Spain, percent of World
1980	99.076	N/A	4.896%	1.348%
1981	99.205	0.130%	4.932%	1.339%
1982	99.595	0.393%	4.923%	1.316%
1983	104.163	4.587%	4.996%	1.324%
1984	108.653	4.311%	4.963%	1.300%
1985	111.865	2.956%	4.906%	1.292%
1986	114.255	2.137%	4.884%	1.286%
1987	114.291	0.032%	4.740%	1.232%
1988	115.046	0.661%	4.667%	1.187%
1989	125.846	9.388%	4.995%	1.243%
1990	129.205	2.669%	5.114%	1.244%
1991	131.888	2.077%	5.192%	1.246%
1992	133.882	1.512%	5.263%	1.257%
1993	133.812	-0.052%	5.267%	1.232%
1994	139.556	4.293%	5.421%	1.256%
1995	145.322	4.132%	5.501%	1.266%
1996	150.555	3.601%	5.530%	1.275%
1997	162.439	7.893%	5.883%	1.340%
1998	168.311	3.615%	5.965%	1.353%
1999	180.442	7.207%	6.314%	1.421%
2000	193.577	7.279%	6.577%	1.468%
2001	206.166	6.503%	6.844%	1.529%
2002	211.491	2.583%	6.943%	1.519%
2003	222.139	5.035%	7.150%	1.538%
2004	234.112	5.390%	7.361%	1.550%
2005	244.841	4.583%	7.580%	1.556%
2006	261.349	6.742%	8.007%	1.595%
2007	262.437	0.416%	7.957%	1.534%
2008	N/A	N/A	N/A	N/A
2009	N/A	N/A	N/A	N/A
2010	N/A	N/A	N/A	N/A

Source: The TitiTudorancea Bulletin, 2012. Available online at: http://www.tititudorancea.com/z/ies_spain_electricity_consumption.htm

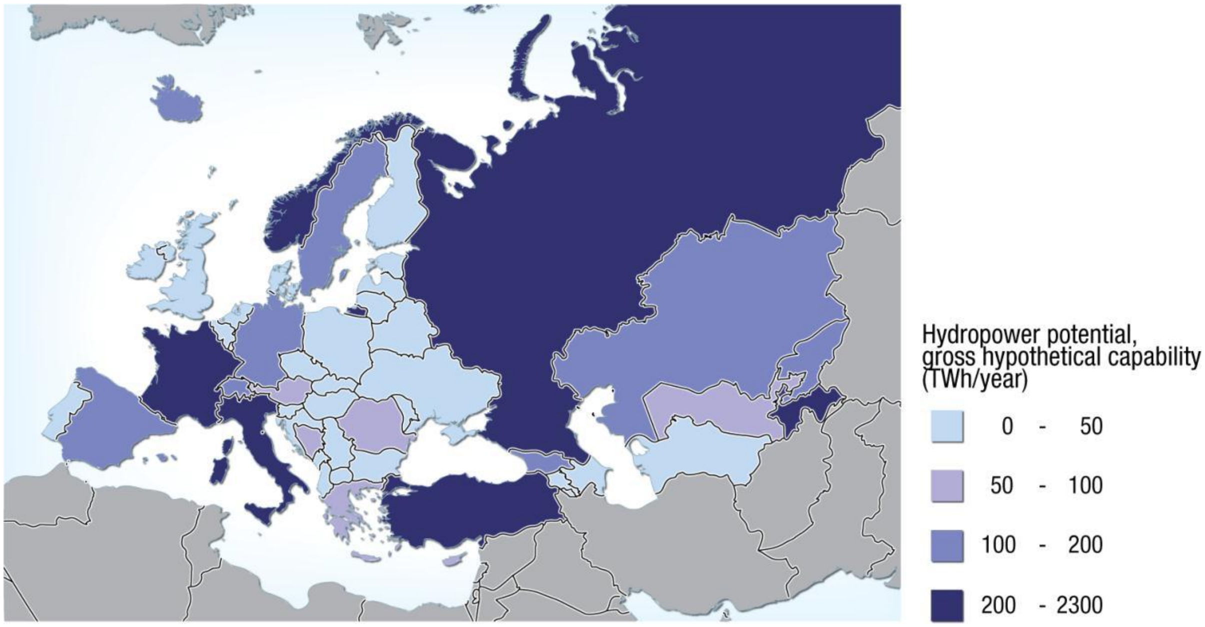
10. <u>Appendix 2</u>

Figure 1: Global Horizontal Irradiation Map of Europe



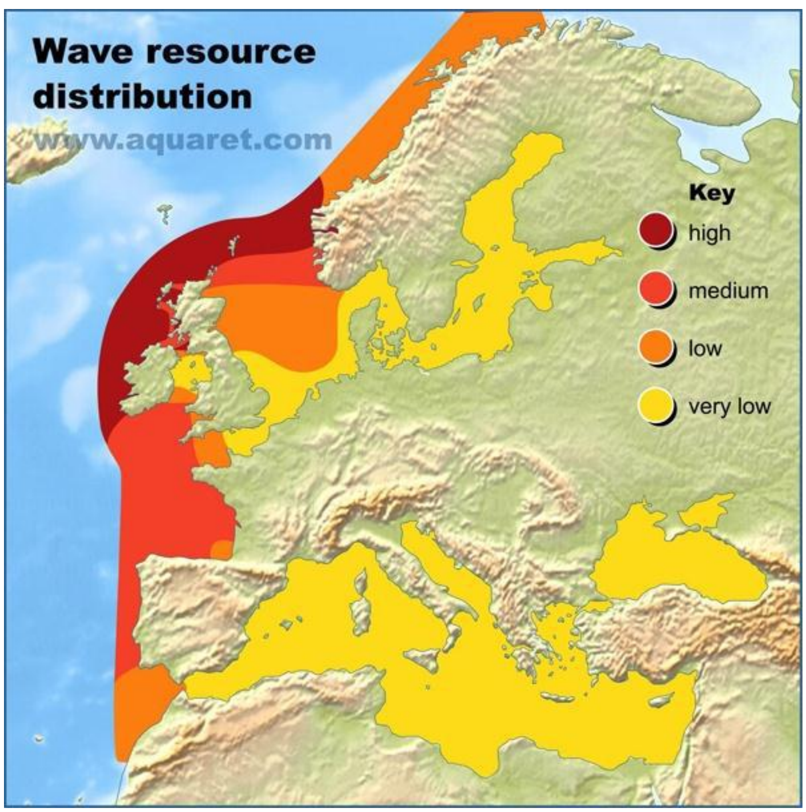
Source: SolarGIS

Figure 2: Theoretical Hydropower Potential of Europe



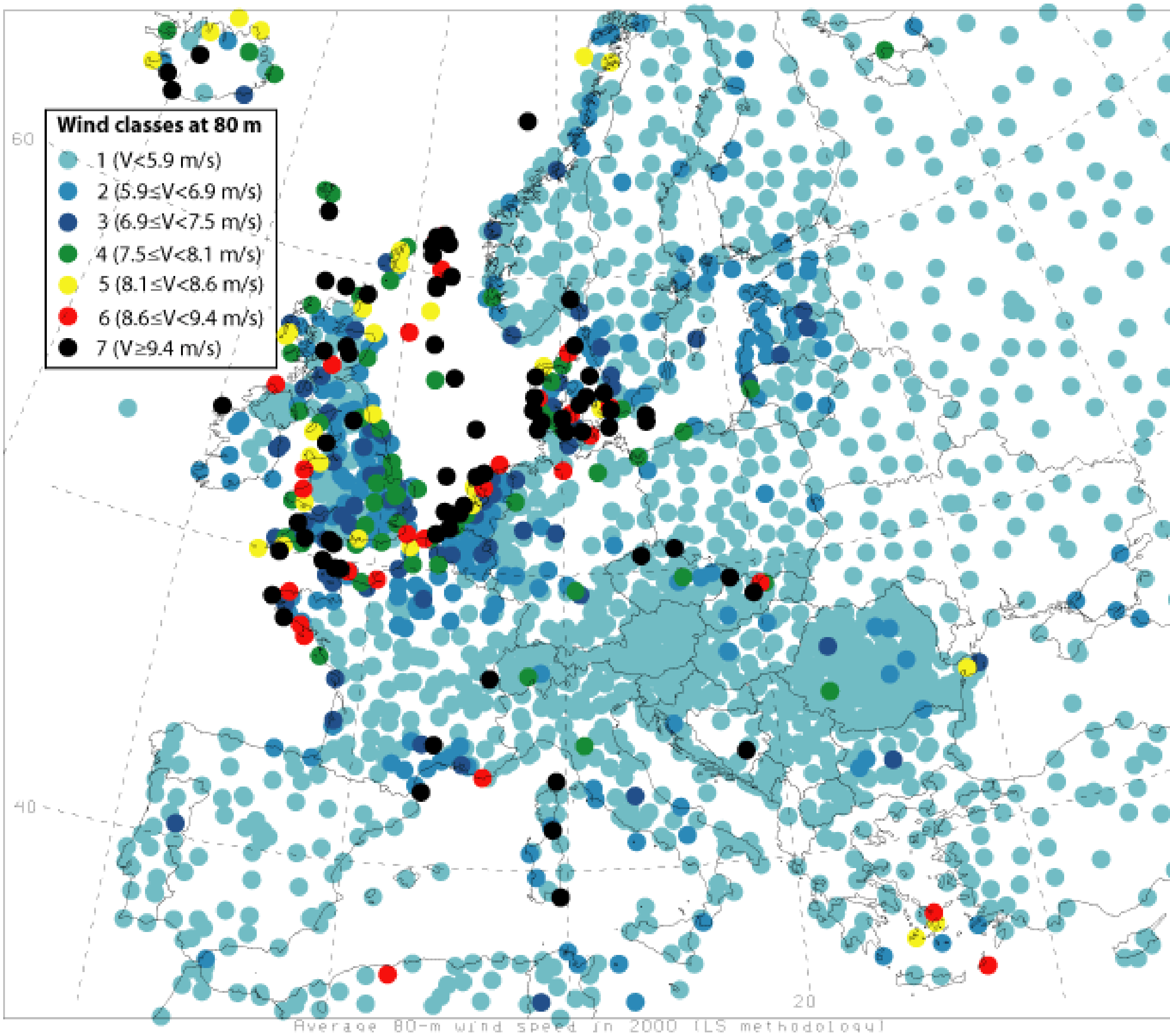
Source: UNEP/GRIDA

Figure 3: Wave Resource Distribution of Europe



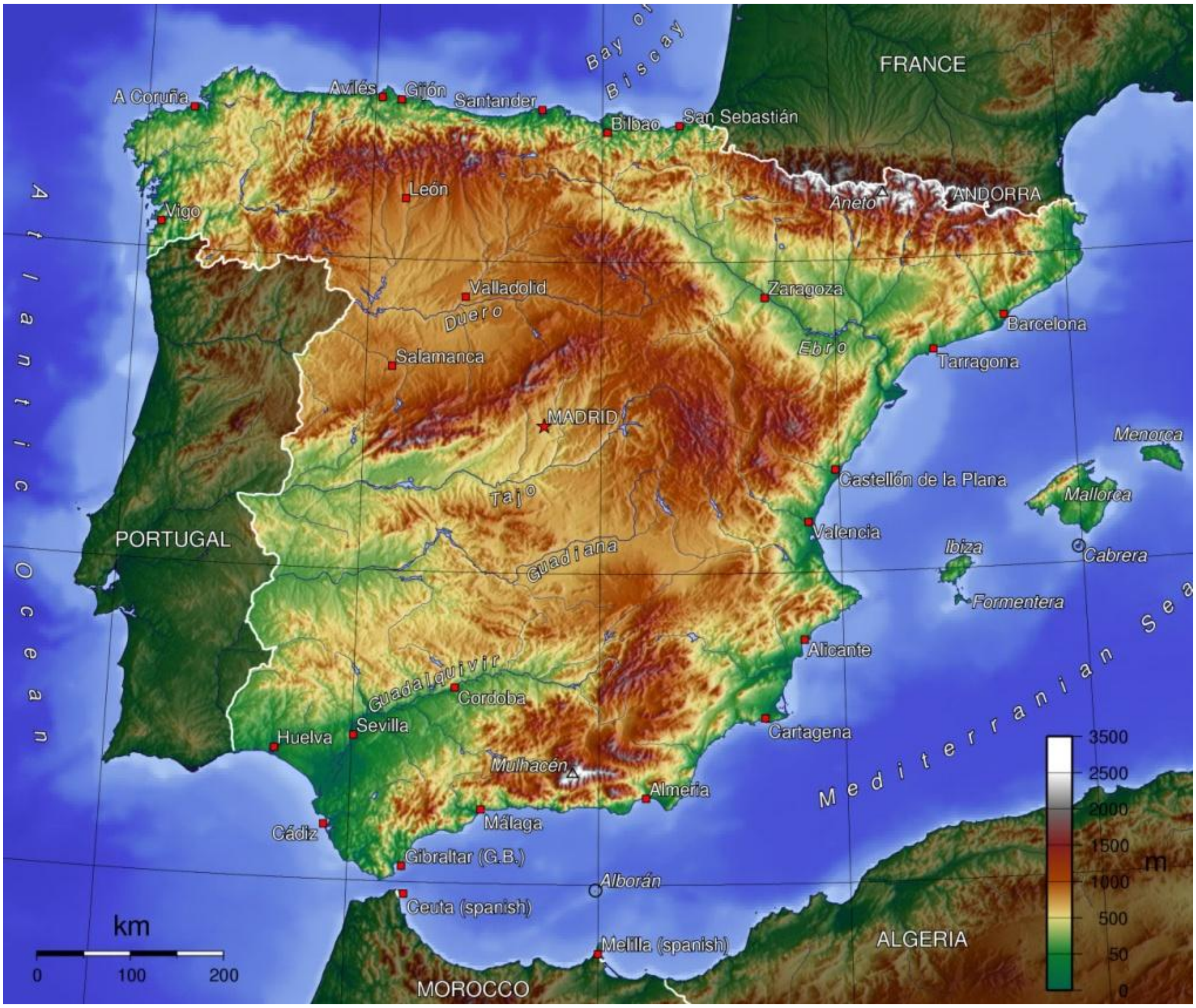
Source: Aquaret

Figure 4: Map of wind speed extrapolated to 80 m and averaged over all days of the year 2000.



Source: Evaluation of global wind (Archer & Jacobson, 2005)

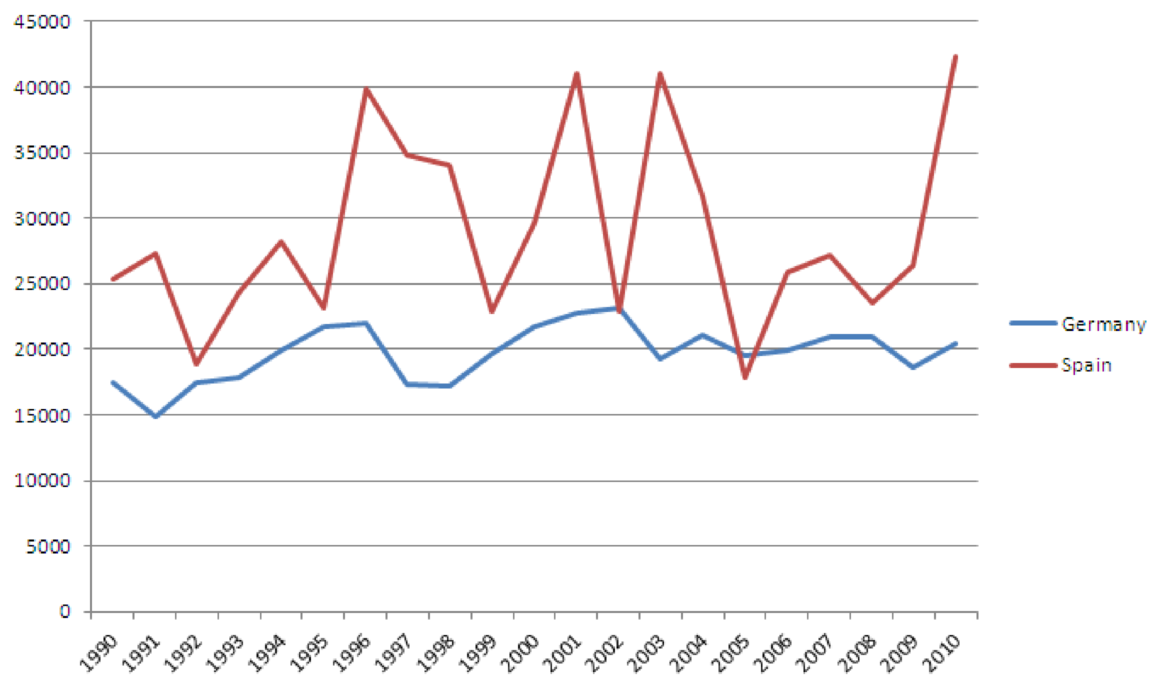
Figure 5: Spain topographic map.



Source: http://www.educolorir.com/imagem-mapa-topografico-da-espanha-i17047.html

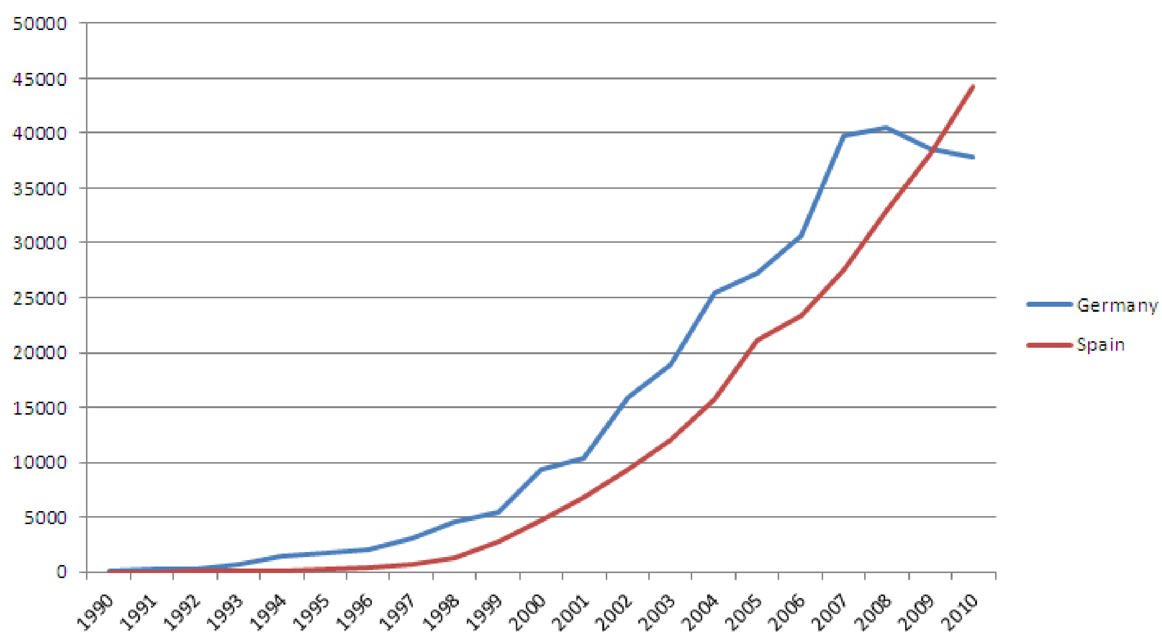
11. Appendix 3

Figure 1: Electric energy production by Hydropower between 1990 and 2010 (GWh)



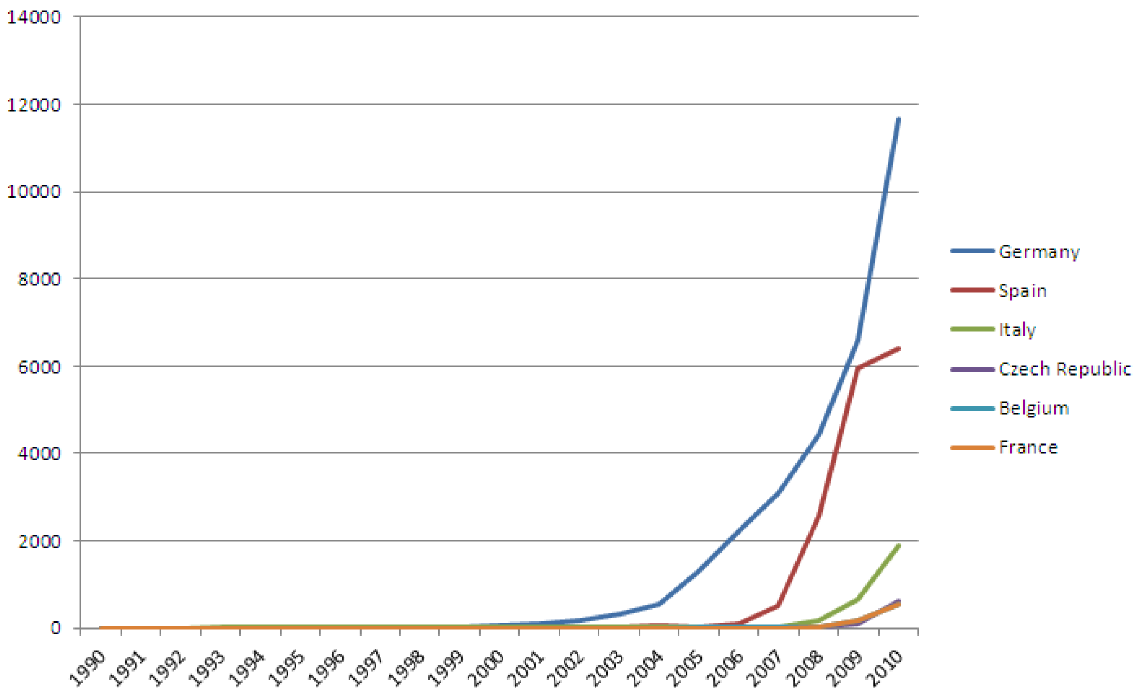
Source: Eurostat 2012

Figure 2: Wind electric energy production between 1990 and 2010 (GWh)



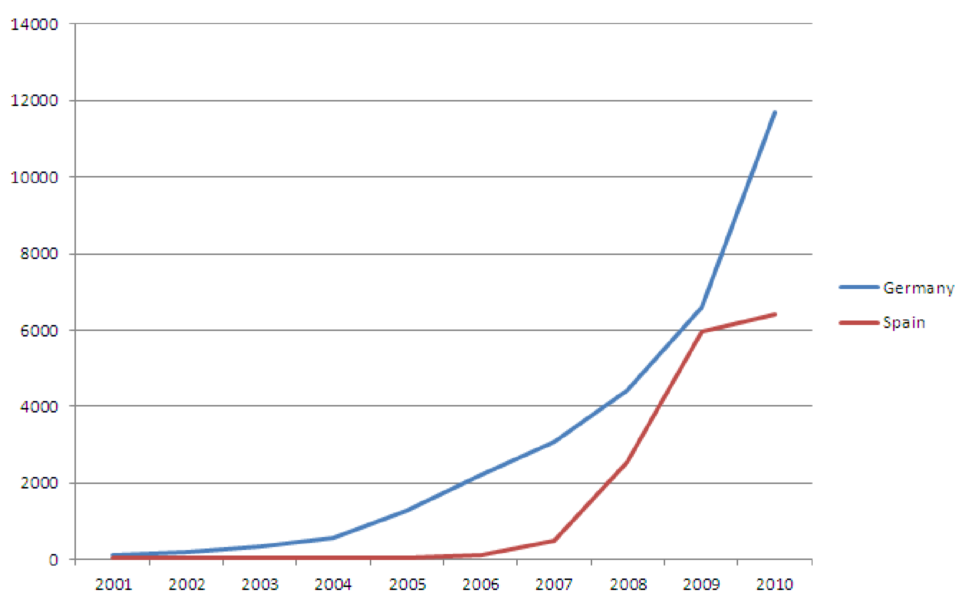
Source: Eurostat 2012

Figure 3: Electric energy generation PV in GWh (1990-2010)



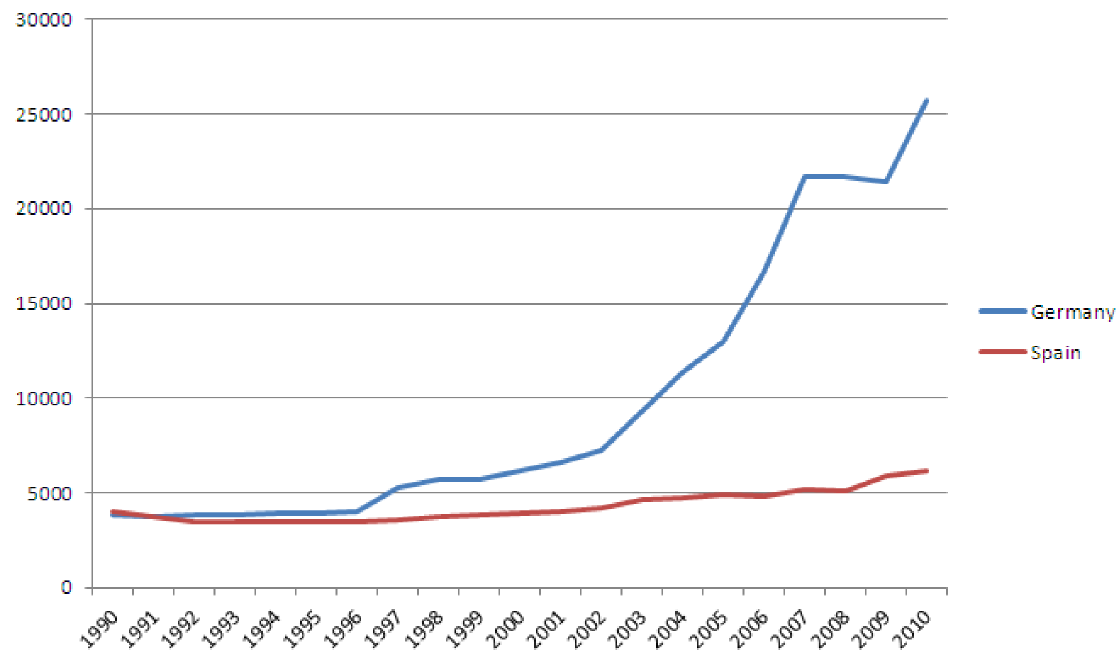
Source: Eurostat, 2012.

Figure 4: Solar PV electricity generation between 2001 and 2010 (GWh)



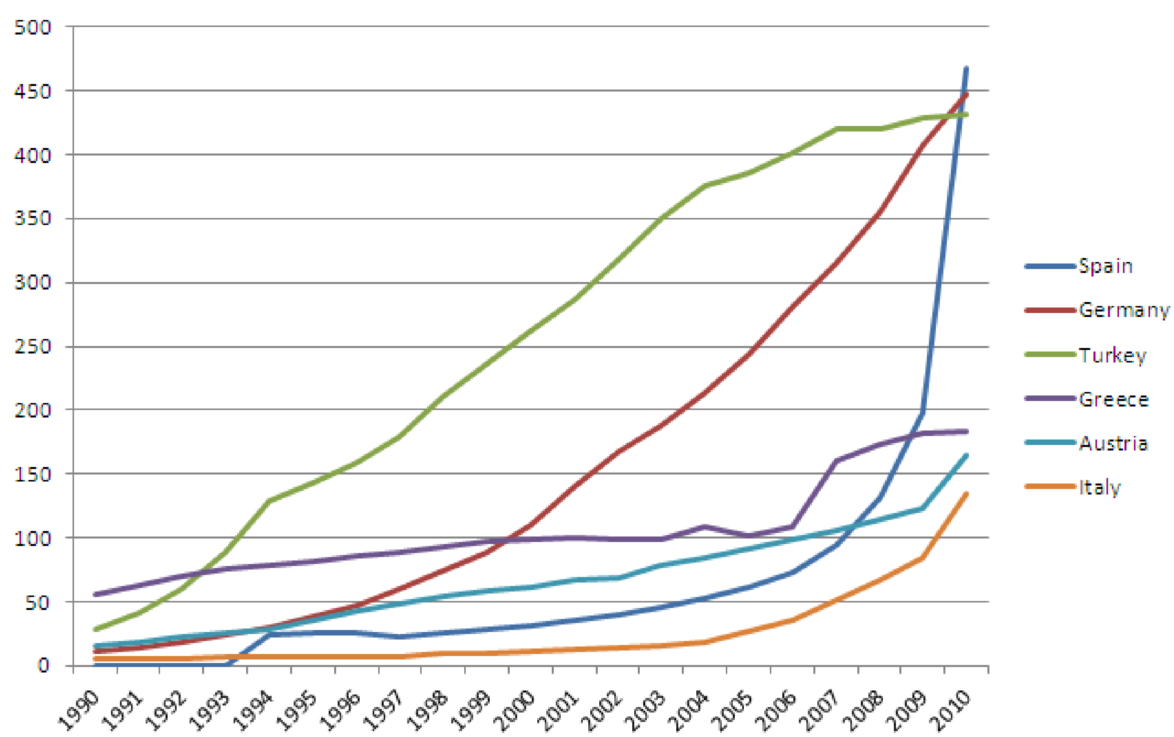
Source: Eurostat 2012

Figure 5: Electricity and heat produced by biomass between 1990 and 2010



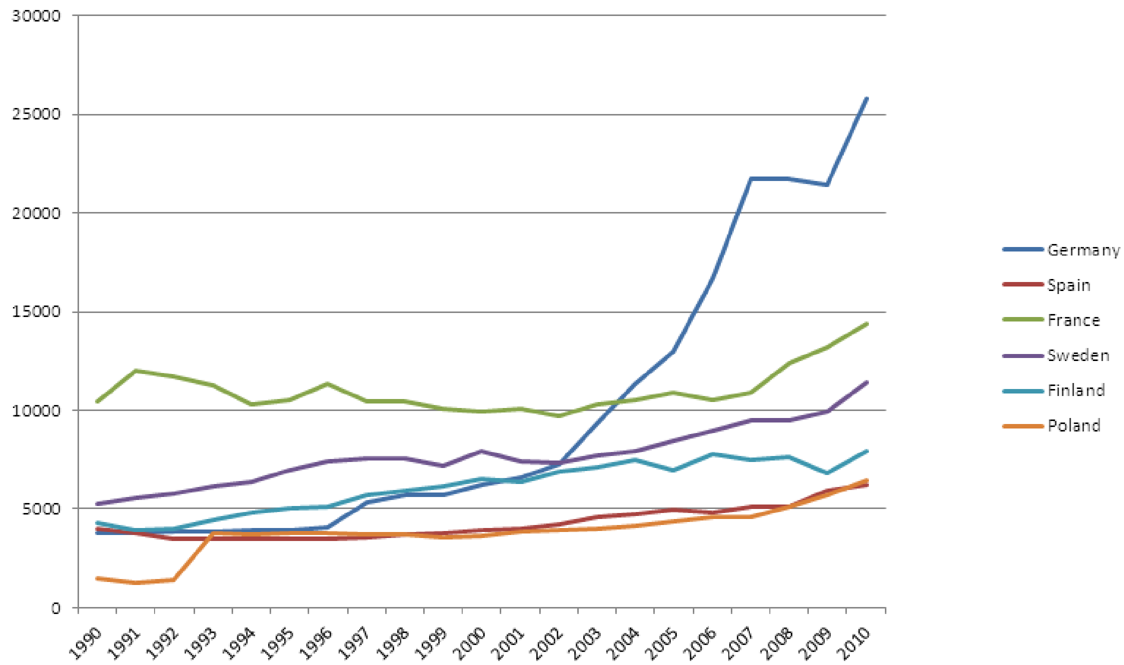
Source: Eurostat 2012

Figure 6: Energy produced by solar thermal between 1990 and 2010



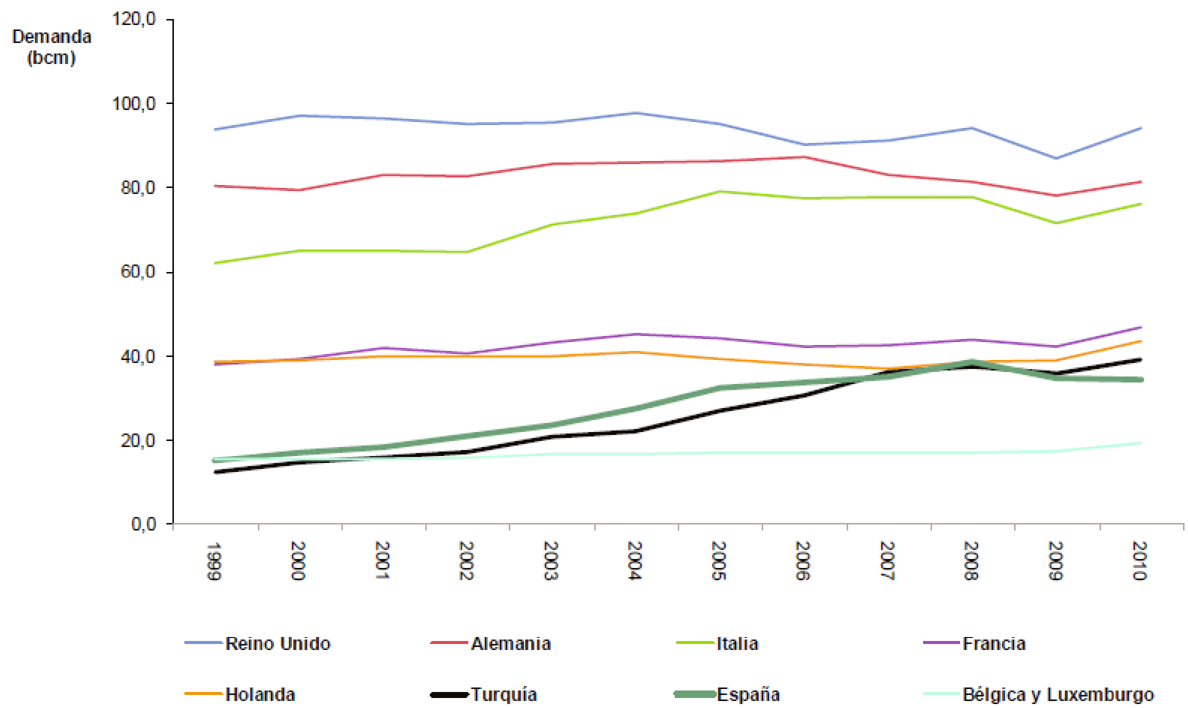
Source: Eurostat 2012

Figure 7: Electricity and heat production by Biomass in TOEs (Tonnes of fuel equivalent) (1990 – 2010)



Source: Eurostat, 2012.

Figure8: Natural gas demand, Europe



Source: CNE, 2011