UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE ELECTRIC POWER INDUSTRY

Master’s Thesis

THE WACC AS A METHODOLOGY TO APPROXIMATE THE SPREAD FOR THE ALLOWED RATE OF RETURN FOR RENEWABLE GENERATION AND GENERATION IN ISOLATED ENERGY SYSTEMS IN SPAIN

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Madrid, July 2017

Official Master's Degree in the Electric Power Industry (MEPI)
Erasmus Mundus Joint Master in Economics and Management of Network Industries (EMIN)

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Summary

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Master in Economics and Management of Network Industries (EMIN)

Master in the Electric Power Industry (MEPI)

The WACC as a Methodology to Approximate the Spread for the Allowed Rate of Return for Renewable Generation and Generation in Isolated Energy Systems in Spain

The Spanish electricity regulatory framework states that the regulated sectors must be remunerated through a reasonable rate of return, calculated as a spread to be added to the average government bonds yield. In that context, the objective of this work is to use the well-known financial model of the Weighted Average Cost of Capital (WACC) to approximate the allowed rate of return for renewable energy generation and generation in the isolated energy systems. As of today, the allowed rate of return has been set without any clear methodology. This work pretends to provide the regulator with a replicable methodology that can be used in the following regulatory periods and that is clear to all stakeholders. The WACC / CAPM model is selected because of its widespread use among energy regulators and within different industries.

The methodology followed consisted on an extensive analysis of the Spanish regulatory framework and a comprehensive benchmarking of selected European cases that could provide additional insights and research elements. Although in general this work has relied on the WACC /CAPM model, it has been supplemented: in spite of its extensive use and strong grounding in financial theory, the WACC/CAPM model has certain limitations that make it unsuitable as the sole model for assessing rates of return to renewable projects. To tackle some of these insufficiencies, the model has been complemented to include asymmetric risks and price risk. A liquidity test was also added to the methodology. In the same way, it was decided that the peer group of companies used to calculate the rate of return for generation in the isolated systems will be the same as the one used for transmission and distribution activities. Regarding the methodological choices to the CAPM, like frequency of the data or reference market used, a complete analysis is presented.

The results suggest that the WACC/CAPM based rates of return are lower (in approximately 60bps) than the allowed rates in the current regulatory framework. This can be explained through the differences in the economic environment when those rates were set and nowadays, even though historical data of the past 6 years have been considered. These differences in the economic situation should be taken into account on the next regulatory period. Regarding the existing spread between the rate for renewables and the rest of regulated activities (Namely, T&D and Isolated Systems) the obtained results are in line with the present regulatory framework, with a difference of about 100bps.

Acknowledgements

I would like to express my gratitude first to Ms. Henar Soto Tejero of the Energy Division of the CNMC for supervising this thesis project and whose expertise, understanding, and constant support are an integral part of this work. I would like to thank as well to Francisco Fournier, his help and contributions where a vital part of this master's thesis. Finally I want to thank the CNMC for making possible this internship experience.

A special thanks to the EMIN coordinators and supporting staff for their support and guidance during these two years of constant learning and adventures and to my fellow EMIN friends that made this time an unforgettable experience.

In addition, I want to thank my family and friends for their support and love.

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Chapter 1

1.Introduction

In the electric industry there are some sectors of the value chain that are characterized as competitive ones, namely generation and retailing. The former one has successfully worked under different competitive schemes. Regulated pools, bilateral contracts or Security Constrained Economic Dispatch are some of the approaches used worldwide to face this mission. However some aids and additional supports have been awarded in the cases were the competitive outcome does not allow the companies to recover their costs.

Under the current development of green economies, the arising of electricity production through renewables sources seems to increase year by year. The EU's Renewable energy directive has set a binding target of 20% final energy consumption from renewable sources by 2020. To achieve this goal the Spanish government has established a fixed rate of return that renewable projects should receive throughout their participation in the market and additional subsidies.

In the same way Spain has some insular and extra peninsular systems where the generation costs are higher than in the peninsula because of the particular characteristics of those systems, characterized by small size generation power plants, expensive logistic costs and lack of cheap fuel alternatives. In order to address this problem the Spanish regulator has designed a regulated remuneration mechanism. The generation in these systems is remunerated taking as a reference the price structure of the peninsular system, to which an additional remuneration concept is added, that takes into account all the specific costs of these systems and the costs of this electric energy production activity that could not be recovered by the income obtained in the peninsular market. The investment costs are recovered with an allowed rate of return.

Another issue that will be covered in this thesis has to do with analyzing possible remuneration schemes to the new investments in smart grids made in Transport and Distribution activity in Spain. The smart grids are roughly those ones that can efficiently integrate the behavior and actions of all users connected to them, so as to ensure a sustainable and efficient energy system, with low losses and high levels of quality and security of supply. The investment on those grids involves the use of technologies that are different to the ones used traditionally in the distribution and transmission networks. They have shorter lifespans and higher technological risks. A pending regulatory task is to determine a possible differentiated remuneration scheme awarded to new investments in smart grids in order to encourage their deployment. At the same time this measure would seek to enhance the research and development by the companies towards the development of optimized tools adapted to the Spanish grid.

There are several methodologies to determine the allowed rate of return; however, most of the European regulators fix it in accordance to the referenced WACC of the activity concerned. Conversely, in Spain the WACC is not used in the present time regulatory framework. The rate of return for renewable generation has been set up as a fixed value of 7.503%, whereas the rate of return for generation in isolated systems is 6.503% for the current regulatory period. However, it is expected to be reviewed at the beginning of each regulatory period from now on. On the other hand, investments in smart grids are currently remunerated as any other investment in Transmission and Distribution networks, being the rate of return for these activities 6,503% at the current regulatory period.

Finally, the current regulatory period started in January 1st, 2016 and it will come to an end on December 31st, 2019. On the other hand, the new regulatory period, which is the aim of this thesis work, will start the first day of 2020 and it will finish in 2025; the allowed rate of return will be set based on the average of the Spanish 10-Year bond plus a spread.

1.1. Motivation of the thesis topic

According to the law, the allowed rate of return for the next regulatory period applying for the regulated remuneration to renewables and isolated generation activities will be computed as the average yield of the Spanish 10-Year bond in the 24 months prior to the month of May of the year before the beginning of the regulatory period plus a spread – translated into basis points (bps). It is set by law that the allowed rate of return for Transmission, Distribution and Generation at the isolated systems can´t vary more than 50 basis points a year. This layout is not applicable for the allowed rate of return applying to Generation with renewable energy sources.

Given the current regulatory framework in Spain, the motivation of this thesis comes from the necessity to define the spread that will be added to set the new allowed rate of return.

The law stipulates that CNMC can be requested to submit to the Ministry of Energy, Tourism and Digital Agenda, a proposal for the spread to be added to the 10 year Spanish Bond, a year and a half ahead the new regulatory period. For the next regulatory period, starting 1st January 2020, in case CNMC is requested, its proposal would have to be evacuated before 1st July 2018.

In addition to this, several agents such as stakeholders, can submit their proposals for the spread to be added to the rate of return for transmission, distribution and generation in the isolated systems before 1st March 2018. The Ministry can also contract a specialized entity to come up with a proposal. These two provisions are not set for RES.

Therefore, it is of great interest to find a methodology to propose the previous mentioned spread.

Although it might be reasonable to think that the aim of this thesis is to suggest a final valuation for the so-called spread, the true goal is to go beyond this scope and propose a methodology – in accordance to the principles and criteria established by law – that can be applicable in similar regulatory frameworks and different regulatory periods, based on the stability principle that is required to strive a mature regulatory environment.

The rate of return of the current regulatory period was computed without any publicly available methodology in 2013; it was made up the average yield of the previous three months before Royal Decree-Law 9/2013 was published of the Spanish 10-years bond plus a spread of 300 bps for renewable generation and 200bps for generation in isolated systems, transmission and distribution; there was no reasoning to select such months or such spread.

As Royal Decree Law 9/2013 entered into force 14th July 2013, the months computed for the Spanish bond yield were April (4,59%), May (4,25%) and June of 2013 (4,67%), being the average yield 4,503%.

Probably, the rate of return was set by the government in accordance to the economic situation of Spain at that given time, in which increasing deficit and an economic crisis were present. Hence, the rationale behind this decision could have been: setting a low - long term (and stable) – rate of return with the objective to reduce the risk for the investors while providing an acceptable value that would not increase significantly the electric system costs.

In earlier regulatory periods, more reasonable methodologies were used. In 2008, the former national regulatory authority for energy in Spain (CNE) developed a methodology based on the WACC that was employed in order to set the rate of return for the distribution activity and only suitable for the investment of new assets.

A previous thesis work[1] has proposed a robust methodology for the calculation of the allowed rate of return for transmission and distribution networks in Spain. That methodology will be a foundation for the present work, as an integrated framework is required to come up with a sound methodology that can be applicable to all activities. Basic elements regarding the calculation of the WACC will not be modified in this thesis. Although some methodological elements will be added. The scope will be to adapt this methodology to achieve the objectives presented in the following section.

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[1] "The WACC as a Methodology to approximate the spread for the allowed rate of return in the Spanish Framework", by Francisco Fournier, 2016

1.2. Objectives

The objective of this thesis is to propose a reasonable and suitable methodology to compute the spread to be added to the rate of return for:

a. Renewable generation, taking into account the current economic context and the current regulatory framework in Spain.
b. Generation in isolated systems, taking into account the current economic context and the current regulatory framework in Spain.

Although the methodology is aimed at the next regulatory period, it will be proposed as to be applied subsequently in further regulatory periods. Being consistency, stability and predictability three basic values of any regulatory framework.

Therefore, the purpose is to provide a common methodology for the allowed rate of return for transmission and distribution activities, renewable generation and generation in isolated systems, taking into account the specificity of each activity. The numerical calculations will be done within the same period of study so that the results will be comparable among all activities.

A brief introduction to the remuneration of smart grids will be presented, although the suggestion of a methodology to approximate their remuneration is out of the scope of the present work.

It is very important to state that this thesis is not expected to include proposals to reform the current regulatory framework but to work within the existing one in order to come up with feasible and reachable conclusions.

1.3. Structure of the report

The structure of this report is composed by seven chapters which are explained as following: chapter one introduced the importance, objectives and motivation of this research; also, basic notions regarding the Spanish regulatory framework were provided.

Chapter two aims to explain the theoretical principles and the main concepts to take into account regarding the sectors and topics studied in this thesis: Renewable Energy Sources, Isolated Energy Systems, Smart Grids, Cost of Capital (WACC) and the Allowed rate of return. The explanation provided will be general, hence the Spanish case will not be accentuated.

Later, general backgrounds will be approached in chapter three in order to understand the industries and the existing regulation (concerning the remuneration) applied in Spain; by doing so, the proposed methodology will be constrained and aligned by the specifications of the regulatory framework.

Chapter four will be devoted to analyze the state of the art in the topic. In first place the methodology proposed by (Fournier, 2016)) for T&D (transmission and distribution) activities will be discussed.

That methodology will be considered the foundation for the methodology proposed in this thesis. After that, a benchmarking analysis of current methodologies applied in some European countries related to the activities studied in this thesis will be done. Finally a CNMC`s previous methodology regarding the setting of airport tariffs will be presented, as it includes a WACC calculation.

Afterwards, in chapter five the proposed methodology for each of the sectors will be presented. In the case of smart grids, only general ideas of a possible pathway to remunerate them will be presented. Next the results will be discussed and contrasted with the current regulatory figures in Spain. This analysis involves different cases and scenarios.

Chapter seven will offer the final conclusions and limitations of this thesis report and the proposed direction to be followed for further research.

Chapter 2

2.Theoretical principles

The following section aims to provide the theoretical foundations for the development of this thesis work. The first part of this chapter is devoted to the different sectors covered in the objectives, namely renewable energy sources, isolated energy systems and smart grids. Afterwards, a brief explanation of the WACC will be presented, since it is the methodology used as base for the calculation of the allowed rate of return for the different sectors.

2.1. Renewable energy sources (RES)

Renewable Energy (RE) is any form of energy from solar, wind, geophysical or biological sources that is replenished by natural processes at a rate that equals or exceeds its rate of use. RE is obtained from the continuing or repetitive flows of energy occurring in the natural environment and includes resources such as biomass, solar energy, geothermal heat, hydropower, tide and waves, ocean thermal energy and wind energy. However, it is possible to utilize biomass at a greater rate than it can grow or to draw heat from a geothermal field at a faster rate than heat flows can replenish it. On the other hand, the rate of utilization of direct solar energy has no bearing on the rate at which it reaches the Earth. Fossil fuels (coal, oil, natural gas) do not fall under this definition, as they are not replenished within a time frame that is short relative to their rate of utilization. (IPCC, 2012)

Royal Decree 413 (2014) provides the foundations for the remuneration scheme used for RES in Spain. In the frame of this Spanish Law (2014), we will consider under the term RES all the renewable energy sources generation facilities, cogeneration (combined heat and power (CHP)) and waste to energy facilities. Although the latter technologies are not considered as renewable sources, they are subject to the same regulatory framework in Spain. In line with this framework, Royal Decree 413 (2014) provides a list of categories to define and classify RES in Spain:

Category A. Producers using CHP or other forms of electricity production from waste to energy.

A.1) Facilities that include a CHP plant.

A.2) Facilities that include a plant that uses residual energies from any facility, machine or industrial process whose purpose is not the production of electric energy.

Category B. Plants which use as primary energy non-fossil renewable energy sources.

B.1.) Facilities that use solar energy as the primary energy. This group is divided into two subgroups:

B.1.1) Solar photovoltaic (PV) technology.

B.1.2) Solar thermal energy (Solar CSP)

B.2) Facilities that only use wind energy as primary energy. This group is divided into two subgroups:

b.2.1) onshore wind facilities.

b.2.2) offshore wind facilities.

B.3) Facilities using geothermal, hydrothermal, aerothermal, wave, tidal, dry and hot rock and ocean thermal energy conversion.

B.4) Hydroelectric plants whose installed capacity does not exceed 10 MW.

B.5) Hydroelectric plants with an installed capacity exceeding 10 MW.

B.6) Power generation plants or CHP plants using as main fuel biomass from energy crops, agricultural, livestock or gardening activities, forestry and other forestry operations in forest stands and green spaces.

B.7) Power generation plants or CHP plants using bio liquids produced from biomass as the main fuel, the latter being liquid fuel for energy uses other than transport and including use for the production of electrical energy and production of heat and cold, or using biogas from anaerobic digestion of energy crops, agricultural residues, livestock waste, biodegradable waste from industrial facilities, household waste and similar waste, as well as biogas recovered in controlled landfills.

B.8) Power generation plants or CHP plants using as main fuel biomass from industrial facilities in the agricultural or forestry sector.

Category C. Plants using as primary energy waste with energy recovery not covered by Category B.

C.1) Centrals which use domestic waste and similar as the main fuel.

C.2) Plants that use as main fuel other wastes not included in group C.1, or fuels of groups B.6, B.7 and B.8 when they do not comply with the consumption limits established for the aforementioned groups.

European Energy Strategy

Another important element that has motivated the development of renewables in Spain is the European Energy Strategy that has recently been reviewed. The European Union's (EU) energy policies (European Comission, 2017) are driven by three main objectives:

- To secure energy supplies to ensure the reliable provision of energy whenever and wherever it is needed.
- To ensure that energy providers operate in a competitive environment that ensures affordable prices for homes, businesses, and industries

- To have sustainable energy consumption, through the lowering of greenhouse gas emissions, pollution, and fossil fuel dependence.

These goals will help the EU to tackle its most significant energy challenges. Among these, the dependence on energy imports is a particularly pressing issue, with the EU currently importing over half its energy at a cost of €350 billion per year. In addition, the continued use of fossil fuels in Europe is a cause of global warming and pollution.

Among others, key policy areas that will help the EU achieve their goals include:

- A European Energy Union that will ensure secure, affordable and clean energy for EU citizens and businesses by allowing a free flow of energy across national borders within the EU, and bringing new technologies and renewed infrastructure to cut household bills, create jobs and boost growth
- Boosting the EU's domestic production of energy, including the development of renewable energy sources

To pursue these goals within a coherent long-term strategy, the EU has formulated targets for 2020, 2030, and 2050. The 2020 Energy Strategy defines the EU's energy priorities between 2010 and 2020. It aims to:

- reduce greenhouse gases by at least 20%
- increase the share of renewable energy in the EU's energy mix to at least 20% of consumption
- improve energy efficiency by at least 20%

In the same way, EU countries have agreed that the following objectives should be met by 2030:

- a binding EU target of at least a 40% reduction in greenhouse gas emissions by 2030, compared to 1990
- a binding target of at least 27% of renewable energy in the EU
- an energy efficiency increase of at least 27%, to be reviewed by 2020 with the potential to raise the target to 30% by 2030
- the completion of the internal energy market by reaching an electricity interconnection target of 15% between EU countries by 2030, and pushing forward important infrastructure projects.

Together, these goals provide the EU with a stable policy framework on greenhouse gas emissions, renewables and energy efficiency, which gives investors more certainty and confirms the EU's lead in these fields on a global scale.

The EU aims to achieve an 80% to 95% reduction in greenhouse gases compared to 1990 levels by 2050. Its Energy Roadmap 2050 analyses a series of scenarios on how to meet this target, concluding that decarbonizing the energy system is technically and economically feasible. In the long run, all scenarios that achieve the emissions reduction target are cheaper than the continuation of current policies.

2.2. Isolated Insular Energy Systems[2]

A part of this thesis is devoted to propose a methodology to calculate the rate of return to be applied to generation in the isolated energy systems in Spain. Hence, it is important to provide an explanation of what an isolated energy system is and what makes it different from the conventional energy systems. An isolated energy system is defined by a region's inability, due to smallness and/or remoteness, to interconnect with other electricity generators and consumers through a wider transmission grid outside its geographical borders. As a result, the region cannot take advantage of the more efficient neighboring electricity markets. This type of energy system is typically detected in small islands where the costs for constructing infrastructure for power transmission purposes to the mainland are high. (Fokaides, 2014)

A number of factors make the electricity generation of insular systems more expensive and less secure in the long term. First the insular systems are characteristically greatly dependent on imported energy sources for electricity generation, whose high transportation costs should be reflected in the electricity prices (Mayer, 2000). In addition the typically small sizes of these energy systems limit both the production and consumption capacities so that development of economies of scale and establishment of significant internal markets cannot be achieved. (Encontre, 2000) Another characteristic of insular energy systems is the dominance of a sole either public or private enterprise. (Domah, 2002) The islands often present seasonal changes of population, so the daily energy needs in high population periods are significantly greater than rest of the year. This leads to oversizing infrastructure in all fields, as systems sized to accommodate the requirements of the summer period are significantly underutilized in winter time. (Erdinc, et al., 2015) These limitations lead to several negative economic outcomes.

According to their peak power demand (MW) and annual energy consumption (GWh), insular areas are classified into four groups (Bizuayehu, et al., 2014):

- Very small islands (o 1 MW and o 2 GWh)
- Small islands ([1–5 MW] and [2–15 GWh])
- Medium islands ([5–35 MW] and [15–100 GWh])
- Big islands (> 35 MW and > 100 GWh)

Generally, the power systems of insular areas comprise a single or a few, typically conventional fuel based generators, especially in very small and small islands. Thus, the inertia of the total system is

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[2] In further sections a more detailed explanation of the Spanish system will be given, the objective of this section is to introduce to the reader the concept of an isolated energy system,

significantly low and the status of insular power systems can be considered unreliable due to possible outages and fuel shortages for such a small number of generating options. Moreover, most of the generating units as well as other electrical infrastructure components are commonly old and need maintenance more than newly installed systems, an issue that reduces the reliability and economic sustainability. (Erdinc, et al., 2015)

The technical and nontechnical losses in insular areas are considered to have a higher percentage in comparison with large interconnected electrical systems, that promotes the increase of fuel utilization and also the unit cost of electricity (PPA, 2006). Thus, the overall power system operating efficiency is significantly lower compared to mainland that adds further economic burdens on energy serving companies and accordingly end-user customers.

Economic framework of insular power system operation

During the last decades, the organization and regulation of the electricity sector has substantially changed in many countries around the world where vertically integrated companies and monopolies have been or are being replaced by competition and market structures. Restructuring of the electricity sector entails the introduction of several new entities and agents that operate in all levels of the production-to-consumption chain (Conejo , et al., 2010). The power systems of islands pose challenges towards the implementation of market structures and competition because of their peculiarities. The main barriers are (Erdinc, et al., 2015):

- More reserve capacity is required than in the mainland net- works on account of absence of interconnections.
- There are greater environmental requirements and protection of fauna and flora, conditioned by the tourist interest of these territories.
- Provision of electricity is more expensive in insular power systems owing to high fuel transportation costs.
- Limited space, public opposition and local factors do not allow vast investments in conventional power plants.
- RES are alternative candidates for electricity production, promising economic efficiency and sustainability. Nevertheless, network security issues and the interruptible nature of such resources limit the penetration of RES.

Many countries socialize the higher cost of producing electricity in islands among all country population, in order to achieve social fairness.

According to Perez and Ramos (2008) there are several models to introduce competition in isolated electricity markets:

- The single buyer model

- Bilateral contracts
- Wholesale markets (pools).

The single buyer model and bilateral contracts are considered the most appropriate structures for non-interconnected insular power systems. All the insular power systems share the aforementioned limitations. However, the organization of the electricity market may differ significantly from island to island. In Malta, a small-sized island, there exists only a national corporation (Enemalta) that acts as a generator, distributor and retailer. In Malta, the market structure follows the single buyer model since independent producers may sell electricity to Enemalta. Furthermore, consumers have to buy energy from the same corporation since there does not exist any other retailer (Enemalta, 2017). In Cyprus, a non-interconnected island country, the market is based around bilateral contracts. Legislation allows the 67% of the island's electricity consumers to choose their electricity supplier and also foresees for competition in generation. Nevertheless, Electricity Authority of Cyprus remains the only power producer and supplier (EAC, 2017). In Canary Islands (Spain), Red Eléctrica de España (REE) acts as a single buyer using a minimum cost generation scheduling procedure (Perez & Ramos Real, 2008). The island of Crete offers the opportunity of having a pool market structure given the load's demand and its size. It is obvious that although the legal framework regarding insular power systems in many cases allows competition, in practice it is not operational. In order to attract investors' interest and overcome the practical barriers in insular power systems, several alternatives have been considered such as hybrid portfolios (e.g. combining energy storage and RES) and investigating possible interconnections with other nearby islands or the mainland. (Erdinc, et al., 2015)

2.3. Smart Grids

According to the U.S. Department of Energy, < *“Smart grid” generally refers to a class of technologies that people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way digital communications technologies and computer processing that has been used for decades in other industries. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers – mostly seen in big improvements in energy efficiency and reliability on the electricity grid and in energy users’ homes and offices.*> In other words, smart grids are modern power generation and distribution infrastructures which can automate and manage the increasing complexity and need of electricity in the 21st century.

The number of applications that can be used on the smart grid once the data communications technology is deployed is growing as fast as inventive companies can create and produce them. Benefits include enhanced cyber-security, handling sources of electricity like wind and solar power and even integrating electric vehicles onto the grid. The companies making smart grid technology or offering such services include technology giants, established communication firms and even brand new technology firms. This grids will empower consumers with real-time information about their energy consumption.

According to the National Institute of Standards and Technology (NIST) the smart grids will provide several benefits, listed below:

1. Improving Power Reliability and Quality: Better monitoring using sensor networks and communications, better and faster balancing of supply and demand
2. Minimizing the Need to construct Peak Load Power Plants: Better demand side management, the use of advanced metering infrastructures
3. Enhancing the capacity and efficiency of existing electric grid: better control and resource management in real-time.
4. Improving Resilience to Disruption and Being Self-Healing
5. Expanding Deployment of Renewable and Distributed Energy Sources: better renewable energy forecasting models
6. Automating maintenance and operation.
7. Reducing greenhouse gas emissions: Supporting the use of electric vehicles, renewable power generation with low carbon footprint
8. Providing new storage opportunities.

Although the standards (IEEE has over 100 Smart Grid related approved standards) and specific equipment used to deploy smart grids may change from case to case, there are some basic components that fall into the definition of smart grids. (UC Riverside, 2016)

- Intelligent appliances capable of deciding when to consume power based on pre-set customer preferences.
- Smart substations that monitor and control critical and non-critical operational data such as power factor performance, breaker, transformer and battery status.
- Universal access to affordable low-carbon electrical power generation and storage solutions.
- Smart power meters featuring two-way communications between consumers and power providers to automate billing data collection, detect outages and dispatch repair crews faster.
- Smart distribution that is self-healing, self-balancing and self-optimizing, including superconducting cables for long distance transmission and automated monitoring and analysis tools.
- Smart generation capable of learning the unique behavior of power generation resources to optimize energy production and to automatically maintain voltage, frequency and power factor standards based on feedback from multiple points in the grid.

The market size of smart grids has considerably grown over the past few years because of increasing adoption of smart meters, regional government initiatives and funding for smart grid projects, electric vehicles, and rising number of smart city projects across the world. According to Markets and Markets (2016) the major vendors in the smart grid market include ABB Group (Switzerland), General Electric Company (U.S.), International Business Machine (U.S.), Itron Inc. (U.S.), Landis+Gyr AG (Switzerland), Oracle Corporation (U.S.), Schneider Electric SE (France), Siemens AG (Germany), Cisco Systems, Inc. (U.S.), and Open Systems International, Inc. (U.S.). Moreover, the smart grid market size is expected to grow from USD 19.77 Billion in 2016 to USD 65.42 Billion by 2021.

2.4. Weighted Average Cost of Capital (WACC)[3]

The main objective of this thesis is related closely to the WACC. In this section a general explanation of that concept will be provided. The WACC represents the opportunity cost of an investor. Since it is assumed that the capital used by the utilities to invest might come from different sources, a weighted average of such sources is required to get their proportion in the sources funding the utility. However, the two main categories in which they are grouped are: 1) debt and 2) equity.

The 1) cost of debt is related to the interest rate paid to the lenders (namely bondholders and banks), while the 2) cost of equity is associated with the expected rate of return by the shareholders. When comparing the meaning of these two costs, (Pérez-Arriaga, 2013) highlights that “the interest rate on the debt is typically lower than the rate of the return on equity, since the shareholders are more exposed to the financial failure of the company than the lenders”.

Moreover, regulators and investors agree that the WACC should: reflect the cost of opportunity of investor’s capital; and also, measure an expected return from capital’s owners taking into account market’s references; therefore the WACC should provide some insights for the utilities’ most suitable financing strategy. However, from the regulator’s point of view, the rate of return should mostly estimate the cost of capital related to the regulated activities performed during the regulatory period (CNE, 2008).

Equation 2.1 shows the formula of the WACC before taxes. The 1) proportion of debt (also known as gearing ratio) compared to the total sources of funding (Debt + Equity) is multiplied by the cost of debt. On the other side of the formula the remaining part of financing, or 2) the proportion of the equity, is multiplied by the cost of the shareholder’s money.

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[3] This and the following section (Allowed rate of return) of the document are adapted from Fournier (2016)

$$WACC_{bt} = \overset{(1)}{\left[\frac{Debt}{\text{Debt} + \text{Equity}}\right] * R_{debt}} + \overset{(2)}{\left[\frac{Equity}{\text{Debt} + \text{Equity}}\right] * R_{equity}}' \qquad \textbf{2.1)}$$

It should be recalled that the cost of debt is normally lower than the cost of equity. Therefore it might be reasonable to assume that the higher the proportion of 1) debt the lower the value of the WACC; nevertheless, as the proportion of 1) debt increases it implies higher risk of default. Hence, higher gearing ratio involves higher probability of default, which in turn will necessarily imply a higher interest rate that should be paid to the lenders for the risk acquired. This relationship is not simple and involves the concept of an optimal capital structure which in theory should minimize the WACC.

An interesting feature of the WACC is that it can be used as a rate of return to remunerate the investors and, at the same time, as the discount rate when getting the present value of the free cash flow projections. However, since the WACC is usually employed as a measure of the cost of capital of a given utility, the WACC should be represented after taxes and in nominal terms. **Equation 2.2** shows the formula of the WACC after taxes.

$$WACC_{at} = \left[\frac{Debt}{\text{Debt} + \text{Equity}}\right] * R_{debt} * (1 - Tax\ rate) + \left[\frac{Equity}{\text{Debt} + \text{Equity}}\right] * R_{equity}' \qquad \textbf{2.2)}$$

As it can be noted, the formula of WACC after taxes includes a *Tax Rate* term which is multiplied by the 1) debt term. The WACC after taxes explains the real profit obtained by the investors; hence, regulators have to be completely aware of this parameter when setting the rate of return. However, as it will be explained in section 2.5, the WACC will not match perfectly to the allowed rate of return since additional regulatory issues have to be taken into account.

Additionally, **Equation 2.2** shows several parameters to be computed; these can be classified in 4 main categories: 1) Cost of equity, 2) Cost of debt, 3) Optimal gearing ratio, and 4) Tax rate. The computation of each of them will be further discussed in Chapters 4 and 5.

Despite the acceptance of the WACC as an approximation when setting the rate of return, there is not a general consensus among experts and regulators regarding the methodology to compute it; however, basic principles are suggested to take into consideration (Gandolfi, 2009): 1) *transparency* – the methodology to compute each parameter has to be published; 2) *replicability* – utilities and stakeholders must be able to perform the calculations by themselves; 3) *objectivity* – the use of observable market data should be favored over hidden or subjective one; and 4) *realism* – the WACC has to show an attainable financing strategy for the utilities.

Finally, when calculating the WACC of a regulated activity which is not exclusively performed by a given company, difficulties might appear. The most used alternatives proposed when facing this issue involves the calculation of a "*Peer group of utilities*"; in general terms, it refers to computing the average of the data collected from utilities with similar risk profile.

2.5. Allowed Rate of Return

This is the main topic of this thesis. In a competitive market, the companies define their expected rate of return through pricing their products or services; hence, they perceive a given income as a result of their sales; nevertheless, the generation in isolated systems and the T&D activities in the Spanish system are subject to regulated incomes, so a minimum rate of return should be guaranteed to the companies. In the case of renewable generation the companies are exposed to the market but there are support mechanisms in place that will provide the "reasonable return" to the investments. Therefore, the regulator has to set the appropriate rate of return.

The rate of return corresponds to the amount paid to the investors in exchange for the investments incurred. As previously mentioned, the rate of return has to reflect the risk involved in the activity concerned. Lower risk implies more certainty of the incomes the companies will receive and lower cost of the capital demanded by their lenders and investors. On the other hand, higher risk involves an uncertainty regarding the future profit, and consequently, investors and lenders claims for a higher return in exchange of their capital.

When computing the rate of return, the WACC is one of the main parameters taken into consideration; however, it doesn't fully match with the rate of return since other concerns must be included, as well. Some of these additional concerns are related to the regulated revenues, like formulas that update the RAB (if any), and supplementary cost/incomes which are not reflected in the WACC. In addition to these, taxes must be borne in mind.

In most cases, the allowed rate of return corresponds to the WACC before taxes as in shown in equation 2.3.

$$RT = \frac{WACC}{1-T} \qquad \textbf{2.3)}$$

Finally, it can be concluded that the WACC (nominal and after taxes) refers to the rate that the company will offer to its capital providers – lenders and shareholders.

Chapter 3

3.General Framework

3.1. Industry Framework in Spain

The present section will provide a review of the Spanish industries related to this thesis. However it should be mentioned that the smart grids-related activities are enclosed in the T&D activities and will not be discussed here. The reader can find an exhaustive characterization of the Spanish T&D sector in Fournier (2016). Regarding the renewable generation sector and the generation in the isolated systems in Spain a brief description will be presented in order to place the setting and context for the following sections of the document. All the information presented is extracted from public sources and can be check online.

To begin with, it is important to see how the RES and Isolated Generation support scheme costs account among the total regulated costs of the electricity sector in Spain (Figure 1). These regulated costs- which include among others T&D activities, capacity payments and others – are mostly paid by the consumers through access tolls. As a remainder, the regulation in place at the moment in Spain does not recognize any specific remuneration to Smart Grids-related investments, being the rate of return the same as any other T&D investment. A further explanation of this point will be provided in section *Remuneration to Smart Grids investments*.

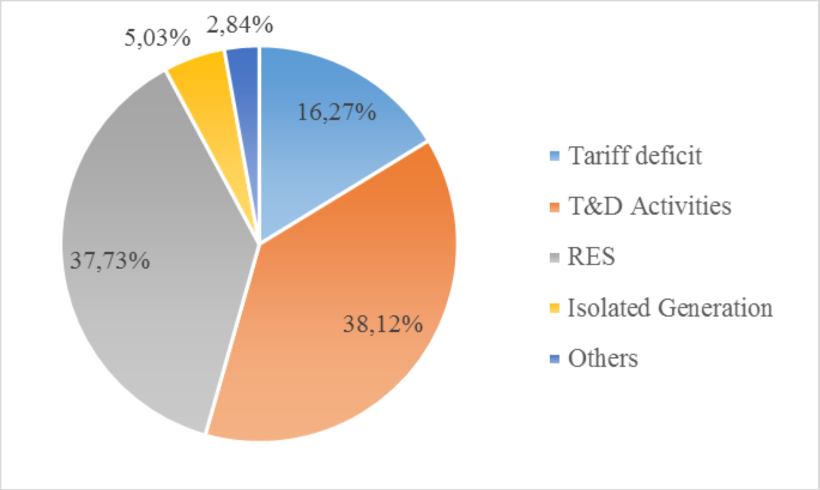

Figure 1. Share of regulated costs among regulated energy sectors in Spain in 2015

In order to give some insights regarding the magnitude of the regulated costs and the relevance of RES and Isolated Generation in Spain, Table 1. Regulated costs in Spain -2015 shows the total regulated costs corresponding to the Spanish electricity system in 2015.

Table 1. Regulated costs in Spain -2015

	Remuneration (in thousands)	%
Tariff deficit	€ 2.888.747,00	16,3%
T&D Activities	€ 6.767.473,00	38,1%
RES	€ 6.698.364,00	37,7%
Isolated Generation	€ 893.137,00	5,0%
Others	€ 504.297,00	2,8%
Total	€ 17.752.018,00	100,0%

The remuneration for the RES support scheme was 6.7 billion euros representing more than 37.7% of the total regulated costs of the system. Whereas the remuneration given to the generation in the isolated systems was 893 billion euros, which represents 5% of the costs of the system. However, the cost of the support scheme for generation in the isolated systems is two times the one that goes into the regulated costs of the electric system. The other half of the cost is covered by the general budget of the country, this means that 50% of the cost is not paid directly through the tolls in the electricity bill but is paid by the taxpayers.

3.1.1. Renewable Energy Sources (RES) in Spain

The total electricity generation of the Spanish System in 2015 was 267,584 GWh, from which 46.4% (Figure 2) came from RES (as said before, being RES renewable energy sources, cogeneration and waste to energy production). In addition to this, RES accounted for 56% of the total installed capacity in 2015.

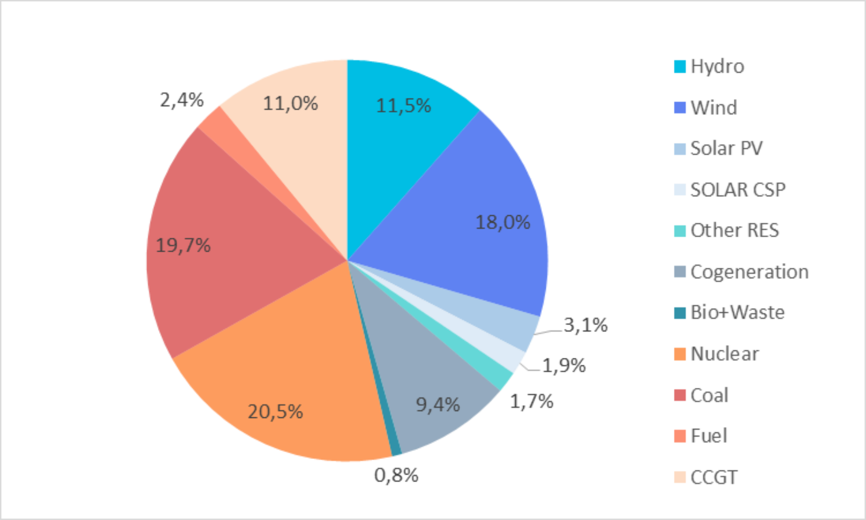

Figure 2. Total generation in the Spanish System - 2015

The remuneration to RES among the total regulated costs of the system is 37.7% as it was shown in the previous section. Hydroelectric technology is divided between small hydro and large hydro. Only the small hydro receives remunerated income. Table 2. Regulated costs for RES in 2015 presents the regulated income for each RES technology in 2015, as well as the energy produced and the number of generating units for each one of the technologies.

Table 2. Regulated costs for RES in 2015

	Energy Produced	**% of Energy Produced**	**Regulated Income (Mill)**	**% of Reg. Income**	**Number of generating units**
Wind	47,764 GWh	49.1%	€ 1,253,570.00	18.8%	1,316
Cogeneration	23,203 GWh	23.8%	€ 1,152,187.00	17.3%	850
Solar PV	7,798 GWh	8.0%	€ 2,434,954.00	36.5%	60,314
Small Hydro	5,205 GWh	5.3%	€ 73,853.00	1.1%	966
Wastes	5,063 GWh	5.2%	€ 219,756.00	3.3%	75
Solar CSP	4,912 GWh	5.0%	€ 1,273,765.00	19.1%	50
Biomass	3,360 GWh	3.5%	€ 261,390.00	3.9%	199
Other RES	5 GWh	0.0%	€ 0.38	0.0%	2
Total	97,310 GWh	100.0%	€ 6,669,475.38	100.0%	63,772

Although Solar PV and solar CSP are not the RES that generate the most in the system, those are the technologies that take the biggest part of the regulated income. Solar PV gets 36.5% of the income and solar CSP 19.1%. On the other hand wind production and cogeneration are by far the technologies that produce the most in the system (49% and 23% respectively) but they just get 18% and 17.3% of the regulated income. The previous figures would suggest that wind generation and cogeneration are more efficient technologies –in terms of costs for the system- than the solar generation.

Regarding the number of generating units it is important to state that in the Solar PV sector there are more than 60,000 producers. The latter shows a fragmented market with several small players and few big companies. In fact, according to a report by Hamalgama Metrica (2015) 80% of the companies in the Solar PV industry are “small” companies with less than 15 employees, 11% of the companies have between 15 and 49 employees and the rest are big companies.

The wind generation business is highly fragmented as well, with more than 1,300 players. Table 3. Wind Generation Installed Capacity 2015. Source: AEE presents the installed capacity in 2015 for this segment. There are only 5 companies with a participation higher than 5% of the total capacity.

Table 3. Wind Generation Installed Capacity 2015. Source: AEE

	Company	Installed Capacity (MW)	%
1	Iberdrola Renovables	5,576.93	24.3%
2	Acciona Energía	4,267.82	18.6%
3	Edp Renovables	2,255.79	9.8%
4	Enel Green Power España	1,491.55	6.5%
5	Gas Natural Fenosa Renovables	1,213.41	5.3%
6	Eolia Renovables	532.3	2.3%
7	Saeta Yield	512.56	2.2%
8	Vapat	471.25	2.0%
9	Rwe Innogy Aersa, S.A.U.	442.71	1.9%
10	Olivento, S.L.	420.79	1.8%
11	Enerfín	390.13	1.7%
12	Viesgo	380.61	1.7%
13	Others	5034.72	21.9%
	Total	**22,990.57**	**100.0%**

The main companies are the following:

Iberdrola Renovables Energía, S.A.U.

Iberdrola Renovables Energía, S.A.U. is a head of business company of the Iberdrola Group headquartered in Spain which performs deregulated activities in generation of electric power using renewable energy sources and whose aim, consequently, is to perform all kinds of activities, work and services related to the business of producing and selling electricity through facilities that use renewable energy sources, including but not limited to, hydraulic, wind, solar thermal, photovoltaic or biomass production; production, processing and commercialization of biofuels and by-products; environmental, technical and financial consultancy, related to this type of facilities. The company has an installed capacity of 5,950MW in Spain.

The aforementioned activities are performed by Iberdrola Renovables Energía, S.A.U. basically in Spain and in the geographical area covering mainly Portugal, Italy, Greece, Romania and Hungary. Iberdrola Renovables was listed in the Spanish stock exchange until 8/07/2011 when it merged with the parent company Iberdrola, S.A. It is officially registered in Valencia. (Iberdrola , 2016)

Acciona, S.A.

Spanish conglomerate group dedicated to the development and management of infrastructure and renewable energy. The company was founded in 1997 through the merger of *Entrecanales* and *Tavora* and *Cubiertas y MZOV*. The company's headquarters are in Alcobendas, Community of Madrid, Spain. The Company employs 30,000 professionals, and has activities in 30 countries on five continents. The Company is IBEX 35-listed. (Acciona, 2016)

It´s energy unit Acciona Energia accounts for 42% of the revenues and 72% of the EBITDA. Acciona Energia operates as an independent power producer and has an installed capacity of more than 8,000 MW worldwide. As of 2016, Spain represented 67% of the group's renewable electricity generation assets. Acciona Energia has assets in Spain in wind power (4,747 MW); Hydroelectric (888 MW), solar thermal (250 MW), photovoltaic (2.48 MW) and biomass (61 MW).

Edp Renovables

EDP Renovables is a company of the Energías de Portugal Group that operates in the field of renewable energy. EDPR was founded in 2007 in order to maintain and operate the renewable energy assets of its parent company. EDP put 25% of the company on the stock market in a Public sale on the Euronext Lisbon stock exchange in June 2008 and became the first member of the PSI-20 benchmark index, being the fifth company by market capitalization. EDPR's activities now include wind farms and, to a lesser extent, mini-hydro power activities. EDP group has recently announced a public offering to re-purchase its subsidy EDP Renovables.

From its 10.4 GW installed capacity, 23% is located in Spain (2,392 MW) and 46% in North America. Today, EDPR is the third largest wind power company in the world according to installed net power. (EDPR, 2016)

Enel Green Power Spain

Enel Green Power Spain (EGPS) is a renewable energy company owned by Endesa, dedicated directly to the generation of electricity from renewable sources. At present it has about 74 wind farms, 4 solar PV plants and 8 biomass power plants, with an installed capacity of 1,706 MW (95% wind). In July 2016 the company was acquired by Endesa Generación S.A, a company wholly owned by Endesa S.A, from the parent company Enel Green Power. The company shares headquarters with Endesa in Madrid. In 2016, the generation of EGPS represented 2% of the total generation of Endesa Generacion.

Endesa Generacion was created on September 22, 1999 to focus on the generation and mining assets of Endesa. The company groups, among others, the interests in Gas y Electricidad Generación, S.A.U. (GESA) (100%), Unión Eléctrica de Canarias Generación, S.A.U. (UNELCO) (100%) and ENEL Green Power España, (100%). As of 2016, ENDESA’s total installed net power in Spain amounted to 21,069 MW.

Gas Natural Fenosa Renovables

It is a company created in 2010 by Gas Natural Fenosa. Gas Natural Fenosa Renovables (GNFR), integrates the renewable energy and cogeneration business lines of the parent company in Spain and at international level. The company is based in Madrid, Spain. The activity of GNFR focuses on the most mature and economically competitive technologies, such as wind, cogeneration and mini-hydro.

Currently, it is the fifth national wind power operator. (Gas Natural, 2016) The company has around 1,200 MW in operation and around 1,500 MW in development.

Eolia Renovables

Independent power producer created in July 2007. Eolia Renovables is dedicated to the promotion, construction and operation of wind farms and photovoltaic solar plants. It currently has 590.3 MW in Spain. Eolia's portfolio is divided into two technologies: 532.3 MW in wind farm operation and 58 MW in photovoltaic solar energy operation. This installed capacity comes from 20 wind farms and 10 PV units. The company is based in Madrid.

Eolia Renovables seeks to position itself as one of the main independent promoters of renewable energies in Spain. To achieve this objective, Eolia Renovables has pursued a strategy of positioning itself as the independent financial partner of medium renewable energy developers (between 50 MW and 300 MW).

3.1.2. Isolated Energy Systems in Spain

Figure 3. Map of Spain

Spain accounts four major territories out of the main peninsula (Figure 3), namely the Canary Islands, Balearic Islands, Ceuta and Melilla. Moreover those regions comprise ten isolated energy systems (In Spanish “Sistemas Electricos no Peninsulares” SEIE) that have the characteristics mentioned in section 2.2. The list of the SEIE is presented in Table 4. The isolated electrical systems will no longer be considered as such when they are effectively integrated with the peninsular system, that is to say, when the capacity of connection with the peninsula is such that it can be incorporated into the peninsular production market and there are market mechanisms that allow integrate its generation. Even though there is an electrical interconnection between Mallorca and the Iberian Peninsula, the Mallorca-Menorca system is nowadays still considered as an isolated system, because of the limited capacity of the submarine cable.

Table 4. Isolated Energy Systems in Spain

Canary Islands	Balearic Islands	Ceuta	Melilla
Gran Canaria.	Mallorca-Menorca.	Ceuta.	Melilla.
Tenerife.	Ibiza-Formentera.		
Lanzarote-Fuerteventura.			
La Palma.			
La Gomera.			
El Hierro.			

As mentioned before, there is a structural limitation on the available generation technologies, which are reduced to conventional medium or small size thermal power plants. The largest of these systems (Mallorca-Menorca) is about 30 times smaller than the peninsular system. And the average size of the generating groups is the SEIEs is much lower than in the peninsula (31 MW per group, on average, compared to 336 MW in the peninsula). In this respect, it is interesting to point out that the number of generation plants installed in the SEIEs is very similar to that of the peninsula.

To guarantee the coverage of the demand, it is necessary to have a reserve margin (Ratio between available generation power and demand peak) much higher than those required in larger systems. The necessary margins are 50-90%, when in the peninsular system they are 10%.

Table 5. Reserve Margins in SEIE

System	**Installed Capacity (MW)**	**Number of plants**	**Mean Size of plants (MW)**	**Target reserve margin**
Melilla	94	8	12	1.9
Ceuta	98	10	10	1.8
La Palma	109	12	9	1.8
El Hierro	123	9	1	1.8
Tenerife	1,056	23	46	1.5
Gomera	23	10	2	1.8
G. Canaria	1,033	21	49	1.5
Lanzarote-FV	399	24	16	1.6
Mallorca-Menorca	1,944	32	61	1.5
Ibiza-Formentera	331	16	21	1.5
SEIEs	5,210	165	31	1.5
Peninsula	54,562	190	336	1.1

All these particularities in addition to the ones mentioned in section 2.2 give rise to higher costs of generation than those of the peninsula - especially as regards fuels - and these costs have a different structure, in which prevails variable costs versus fixed costs. In fact, around 75% of the costs are variable, mainly fuels, due to the already indicated limitations that affect the generation mix. (Rodríguez del Castillo, 2014)

In the SEIEs, generation is an activity that is open to any agent who shows interest in developing activities in these territories. Nevertheless, reality has shown that few agents have had an effective interest in doing so. As a result, it is possible to say that the generation in the isolated areas is provided mainly by three different companies. In the Canary Islands the generation company is Unelco S.A, in the Balearic Islands Gesa S.A, and in Ceuta and Melilla the service is provided by Endesa Generación, that holds 100% stake in both Unelco and Gesa. All these 3 companies are part of Endesa´s group.

Now a brief description of Unelco and Gesa will be presented. These companies are dedicated solely to the generation in the isolated areas, so they could be considered “pure players” in the isolated generation business. Whereas Endesa Generación provides the service in the peninsula and its generation activities in Ceuta and Melilla represent just a marginal part of its income. The regulation of these isolated electricity systems will be discussed in section 3.2.2.

Unión Eléctrica de Canarias Generación, S.A. (UNELCO)

The company was created in 1998 under the name of Union Electrica de Canarias II S.A. and changed its name to UNELCO in 2001. The core activity of the Company is the electric power generation. Endesa S.A. owns 100% stake in the company through Endesa Generación, S.A. At the same time Endesa S.A. is owned by Enel. The company is headquartered in Las Palmas de Gran Canaria.

Total revenues of the company in the year 2015 were EUR 1,206,872,000 and net earnings were EUR 152,428,000. The installed capacity of Unelco is presented in Table 6.

Table 6. Installed Capacity Unelco (2015)

	Installed Capacity (MW)
Hydro	1
Fuel / gas	1.536
CCGT	864
Hydro-wind	11
Wind	153
Solar PV	166
Other RES	3
Cogeneration	33
Total	**2.767**

Gas y Electricidad Generacion S.A (GESA)

The company was created in 1998 under the name Gas y Electricidad II, S.A. and changed its name to GESA in 2001. The core activity of the Company is the electric power generation in the Balearic Islands. Endesa S.A. has 100% stake in the company through Endesa Generación, S.A. At the same time Endesa S.A. is owned by Enel. The company is headquartered in Palma de Mallorca.

Total revenues of the company in the year 2015 were EUR 572,572,000 and net earnings were EUR (1,665,000). The installed capacity of Gesa is presented in Table 7.

Table 7. Installed Capacity Gesa (2015)

	Installed Capacity (MW)
Coal	468,4
Fuel / gas	787,4
CCGT	857,95
Wind	3,65
Solar PV	77,583
Other RES	2,13
Cogeneration	10,825
Waste to energy	74,8
Total	**2.283**

3.2. Regulatory Framework in Spain

This section is aimed to provide the insights to get familiar with the regulatory framework in Spain. Apart from this, the author would like to recall that the objective of the thesis – covered in Section 1.2 – is in line with the proposition of a methodology to approximate the spread to be added to the rate of return for the next regulatory period. Hence, only those features regarding this topic will be highlighted from the vast spectrum enclosed in the relevant legislation.

As a brief introduction, the main concepts of the regulatory framework applicable to the Spanish electricity system are covered by the following points, according to (Ley 24/2013, 2013): 1) the generation of electricity is performed in a free competition scheme; 2) the transmission, distribution and system operation are entitled as regulated activities; 3) the energy dispatch is carried out through a daily market which is organized by the market operator; 4) the generation of electricity from renewable energy sources is subject to regulated remuneration; 5) the retail activity is liberalized and all the consumers must contract that service through a retailer; 6) the access tariffs are the same within the Spanish territory; and, 7) the remuneration for the Isolated generation and generation with indigenous coal is also regulated. (Fournier, 2016)

Important peculiarities of the current regulation that are relevant for the thesis are related to the existence of a unique rate of return that will apply for all the renewable generation technologies; moreover, there will be no differentiation among companies, so the same rate of return will apply for large or small RES projects. Although this generalization is a matter of debate, this research will not attempt to change the current regulation, so no alternative proposals will be suggested regarding this topic.

The methodology to remunerate the RES activities is detailed in the Official State Gazette (known in Spanish as BOE), in Real Decreto 413/2014. Regarding the generation in isolated systems the regulation is stated in Real Decreto 738/2015. Finally regarding the T&D activities (both related to investments in Smart Grids), the regulation is set in (Real Decreto 1047/2013, 2013) for transmission and (Real Decreto 1048/2013, 2013) for distribution. These methodologies have the objective to set the criteria to remunerate the utilities for the different activities object of this thesis. The criteria are homogenous for the whole Spanish territory and based on recognizing the costs incurred by efficient and well managed companies.

3.2.1. Remuneration to Renewable Energy Generation

The remuneration to renewable generation, cogeneration and waste to energy generation is based on the concept of “Reasonable Return ", which is applied on an" Initial Investment” that is calculated at the time that the installation comes into operation. Each type of technology is assigned with a regulatory useful life, during which they may receive a supplement remuneration on investment, in addition to the income from the sale of electricity at market prices. This supplementary income allows the projects to achieve the so-called "Reasonable Return". On the other hand, if market prices get higher than forecasted, RES producers would have to return to the electric system the profits obtained in excess of the “Reasonable Return”.

The concept of reasonable return, which is before taxes, is based on the average yield of the 10-year State Bonds plus the appropriate spread. According to the law, the values for the rate of return are the following:

- Existing facilities before 2013: Ten-year state bonds (average of ten years prior to the entry into force of Royal Decree-Law 9/2013) increased by 300 basis points. (4.398% +3.00% = 7.398%)

- New facilities in the regulatory period 2013 -2019: Ten-year state bonds (average of April, May and June 2013) increased by 300 bp. (4.503% +3.00% = 7.503%)

- Regulatory period 2020-2025 and subsequent: Ten-year state bonds (average of the 24 months prior to May of the year before the start of the regulatory period) plus a spread.

For the calculation of the specific remuneration, the regulator has defined different types of plants according to their technical characteristics. In particular “Orden IET/1045/2014” sets 1.492 different types of plants. For each type of plant, the law sets:

- The revenues from the sale of the energy generated valued at the forecasted market price (and other revenues)
- The average operating costs necessary to carry out the activity
- The value of the initial investment

All these values are calculated for an “efficient and well-managed company”.

There are some criteria to update the values of the parameters.
1. Every 6 years: all the parameters of remuneration and, among them, the value of the reasonable return, can be reviewed. Nevertheless, the regulatory useful life and the standard value of the initial investment will remain unchanged.
2. Every 3 years: estimates of revenues from the sale of energy generated (as a function of the forecasted evolution of market prices and forecasts of operating hours), can be reviewed. In addition to this, the deviations of actual market prices from the estimates made for the previous three-year semi-period are calculated.
3. Annually: values of the operation costs for the technologies whose costs of exploitation depend essentially on the price of fuel.

The new value on which the reasonable return will be set for the next regulatory period will apply to what remains of the regulatory useful life of the facilities for the calculations within the next regulatory period. Nonetheless, it can be reviewed in subsequent regulatory periods.

Before January 1st of the last year of the corresponding regulatory period, the Minister of Energy, Tourism and Digital Agenda shall submit to the Council of Ministers a preliminary draft of Law which shall include a proposal of the value that will take the spread for the rate of return in the following regulatory period, in accordance with the criteria set forth in article 14.4 of Law 24/2013, of December 26. In order to set this value, the Ministry of Energy, Tourism and Digital Agenda may request a report from CNMC to be issued before July 1st of the penultimate year of the corresponding regulatory period, as well as to contract the services of a specialized independent company.

Remuneration scheme

The remuneration scheme is set by the following formula:

$$Re_i \;=\; RInv_i * NP \;+\; ROpe_i \;*\; GE \qquad \textbf{3.1)}$$

Re_i: Total remuneration for the semi-period i for every type of facilities.

$RInv_i$: Remuneration to the investment for the semi-period i, this amount is paid to all the facilities (under certain conditions explained below) regardless the fuel used.

NP: Net installed capacity.

$ROpe_i$: Remuneration to the operation in semi period i (€/MWh.)

GE: Generated energy in semi period I. (MWh)

The remuneration to the operation is awarded under certain requirements:

- Only for the technologies in which the estimated costs of the exploitation by the unit of energy generated are higher than the average estimated price of the market (not including the payments for the capacity). This amount is paid mainly to facilities depending on fossil fuels (cogeneration) and solar plants.
- There is a number of equivalent hours of maximum operation for which the facility is entitled to receive such remuneration to the operation
- Once the plant's service life has been exceeded, an additional remuneration can be established for a limited period of time, which allows economically to continue the operation of the installation

With regard to the remuneration to the investment, this value is explained in **Formula 3.2.** With this formula, a constant annuity is calculated to recover the investment during the regulatory residual life, at a reasonable rate of return.

$$RInv_i = C_i * NPV_i \, \frac{\left(r*(1+\boldsymbol{r})^{rl_i} \right)}{(1+\boldsymbol{r})^{rl_i} - 1} \qquad \textbf{3.2)}$$

C_i: Coefficient of adjustment of the type of the installation in the semi-period i, which represents the part of the investment costs that cannot be recovered in the market. (This coefficient goes from 0 to 1)

NPV_i: Net present value of the asset at the beginning of the regulatory semi-period i for the type of installation, per unit of power (€ / MW). It represents the investment pending to recover, and it's a function of the investment pending to recover at the beginning of the previous semi-regulatory period, of the incomes and costs estimates that were considered for the previous semi-regulatory period, and the adjustment coefficient that represents the deviation from the estimated market price at the previous semi-regulatory period.

rl_i : Regulatory residual life, calculated as the regulatory useful life (UL) minus the number of years that have elapsed since the year the plant started its operation up to the year of commencement of the semi period i.

r : Reasonable rate of return

The NPV is explained in formula 2, considering instalations that have started operations in year a, being year a within the previous semi-regulatory period j-1. For further regulatory periods, the formula is slightly different to consider the NPV at the beginning of the previous semi-regulatory period, and the 3 years of length of the semi-regulatory period. For simplicity, such differences will not be presented in this section.

$$NPV_{j,a} = IV_a\left(1+\boldsymbol{r_{j-1}}\right)^{p-a} - \left[\sum_{i=a}^{p-1}\left(Inc_{i,j-1} - ExpC_{i,j-1} - Adj_{i,j-1}\right)\left(1+\boldsymbol{r_{j-1}}\right)^{p-i-1}\right] \quad \textbf{3.3)}$$

Where:

$NPV_{j,a}$: Net present value of the asset per unit of power, at the beginning of the regulatory period "j", for the installation with final operating authorization in year "a", expressed in € / MW.

IV_a : Value of the initial investment of the facility with final operating authorization in year "a" per power unit, expressed in € / MW.

a: Year of definitive authorization of the type installation.

p: First year of the regulatory semi-period "j".

r_{j-1}: Reasonable rate of return with which to calculate the compensation parameters in the previous regulatory semi-period "j-1".

$Inc_{i,j-1}$: Estimation of the future operating income of the typical installation considered in the calculation of the remuneration parameters of the semi-period "j-1" for year "i", per unit of power, MW.

$ExpC_{i,j-1}$: Estimation of the future operating cost of the typical installation considered in the calculation of the remuneration parameters of the semi-period "j-1" for year "i", per unit of power, expressed in € / MW .

$Adj_{i,j-1}$: Adjusted value for deviations in the market price in year "i" from the regulatory semi-period "j-1" expressed in € / MW. This mechanism corrects possible deviations between the expected price and the average price in the market. In case the prices are below certain limits the companies will be compensated and in the opposite case the companies should reimburse that “extra income”.

In no case the net present value of the asset can be negative, if a negative valuation is obtained from the previous formulation, it will be consider that the value ($NPV_{j,a}$) is zero.

One important element within the remuneration scheme is the forecast of the market price and the adjustments in case of price deviations. To begin, the market price set for each year of the regulatory semi-period shall be calculated as the arithmetic mean of the prices of the corresponding annual futures contracts traded on the electricity futures market organized by OMIP[4] for a period of six months prior to the beginning of the semi-period for which the market price is estimated.

Next, in case of price deviations (the price used to calculate the deviation is the mean price at the end of each year) from the estimated market price, there is an adjustment mechanism. This mechanism which objective is, by defining upper and lower limits to the market price estimate, to generate a positive or negative balance called “adjustment value due to deviations in the market price”. As it was shown in formula 3.3, the adjustment will be compensated over the remaining lifespan of the installation updated with the reasonable financial rate of return. This means that the compensation will be differed on time, so it will not take place during the year when the deviations actually occur.

Regarding the price limits or bands, the law establishes for each year two upper annual limits (LS2 and LS1) and two lower annual limits (LI2 and LI1) in relation to the market price estimated by the Ministry (Pe). These limits define a minimum deviation band (between LI1 and LI2) and two bands of maximum deviation (between the minimum deviation band and the limits LS1 and LS2). The value of the adjustment (V_{adj}) is calculated according to where the mean market price is in relation to these deviation bands, according to the formulas set out in the Royal Decree 413/2014 and which are shown in Figure 4 (where Nh is the Number of hours of operation of the installation):

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[4] OMIP is the derivatives exchange market for Iberian and non-Iberian products that ensures the management of the market jointly with OMIClear, a company constituted and totally owned by OMIP, which executes the role of Clearing House and Central Counterparty of operations carried out on the market.

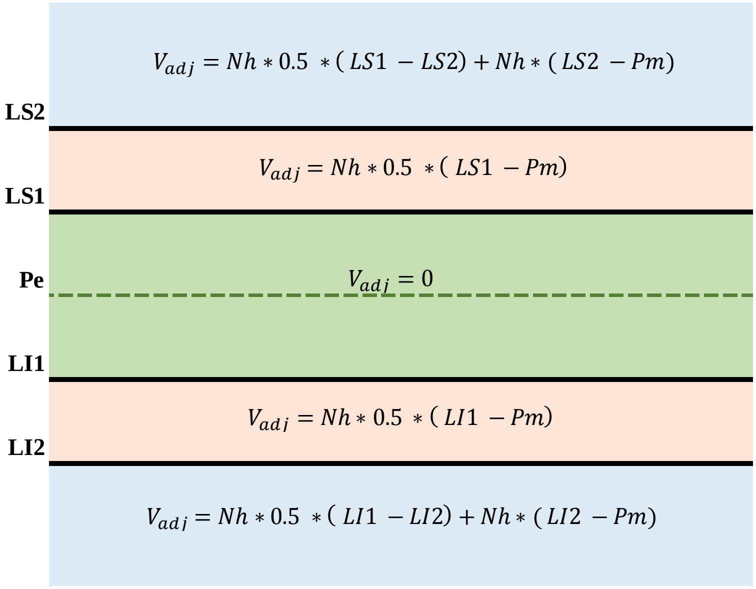


Figure 4. Price adjustment bands

The annual revenue from the remuneration scheme for an installation is also adjusted according to the number of equivalent hours of operation in the same way as follows:

a) In the event that the number of equivalent operating hours of the installation exceeds the number of equivalent minimum operating hours of the typical installation in that year, there is no reduction in the annual revenue from the specific remuneration scheme.
b) If the number of equivalent operating hours of the installation is between the operating threshold and the equivalent minimum operating hours of the typical installation in that year, the annual revenue from the system is reduced proportionately.

For this purpose, the annual income from the remuneration system shall be multiplied by the coefficient "d" (from 0 to 1) calculated as follows:

$$d = \frac{EqH - Th}{MinH - Th} \qquad \mathbf{3.4})$$

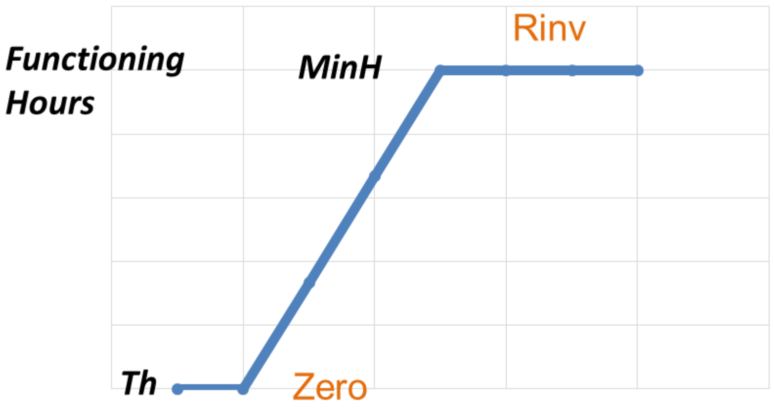
Where:

EqH: Number of equivalent annual operating hours of the facility, expressed in hours.

Th: Operating threshold of the type installation in one year, expressed in hours.

$MinH$: Number of equivalent minimum operating hours of the typical installation in one year, expressed in hours.

In case the number of equivalent operating hours of the installation is lower than the operating threshold of the type installation in that year, the installation owner will lose the right to the specific remuneration regime in that year.



Example:
Wind, Code IT 0655

• MinH: : 1.095 hours

•Operating threshold: 657 hours

Figure 5. Functioning hous mechanism

Since 2013, the granting of the current specific remuneration control is established through a competitive tender procedure (RD 413/2014 and Law 24/2013). However, there are certain exceptions recognized in the current legislation: a quota of 120MW available for facilities other than wind and solar (mainly cogeneration) and a call for wind farms for a total power of 450MW in the Canary Islands territory.

3.2.2. Remuneration to the generation in isolated systems

As it has been mentioned above, the regulation of the generation activity in the isolated Spanish systems does not respond to the continental model of the wholesale market, as this would not give an adequate response to the objectives of guaranteeing the electricity supply and to meet the demand efficiently. Moreover, in Spain the general principle of a single tariff that governs the sector must be respected. That is, all customers, regardless of the place or territory in which they live, have to pay the same final tariffs. Therefore, customers of SEIEs should pay the same tariffs (and be entitled to the same supply possibilities) as peninsular customers, even if the costs are higher in those territories. The latter implies that the costumers of the peninsula will end up paying for the higher costs of the isolated systems through their bills in a “solidarity” principle. The amount of these payments has been presented before, in section 3.1.

As a result of the previous characteristics the SEIEs have been organized in the form of a regulated business where generation dispatch is established by declared variable costs, which works on an order of merit. The dispatch is managed by the system operator (REE - OS). The remuneration scheme includes fixed-cost remuneration with a rate of return **similar to that of other regulated activities** and a variable-cost remuneration for generation taking into account fuel, operating and maintenance costs and modes of operation of a generation unit with an average performance. All the remuneration squeme is refered to an efficient and well-managed company.

This additional remuneration concept will be based on the following principles:

a. Only the specific extra costs of these electrical systems associated with their territorial location and, if appropriate, their isolated character, shall be taken into consideration.
b. For the determination of the investment and operating costs of the electric energy production activity, a typical installation shall be considered, throughout its regulatory life and in reference to the activity carried out by an efficient and well-managed company.
c. In order to allow an adequate remuneration to a low risk activity, the financial compensation of the recognized net investment will be referenced to the yield of the 10 years State Bonds increased with an appropriate spread.

In accordance with the provisions set by article 14 of Law 24/2013, of December 26, to determine the rate of return, the following criteria should be met:

a. Adequate remuneration for a low risk activity, considering the financial situation of the electricity system and the situation of the Spanish economy.
b. Cost of financing of electric energy generation companies in environments with regulated remuneration schemes, based on the recognition of a financial return on investment and operating expenses of efficient and well-managed companies.
c. In any case, the proposed variation of the rate of return between two consecutive years can´t be higher in absolute value than 50 basis points. In the event of a higher variation, the proposed change in value in the rate of return will have to be made in the number of years that are necessary in order not to exceed this limit.

The values of the allowed rate of return are:

Current rate of return: Ten-year state bonds (from the months of April, May and June 2013) increased by 200 bps. (4.503% +3.00% = 6,503%)

Regulatory period 2020-2025: Ten-year state bonds (from the two years prior to May of the year prior to the start of the regulatory period) plus a spread.

Remuneration scheme

As mentioned before the fixed part of the remuneration is the one that will include the allowed rate of return object of this thesis, whereas the variable costs remuneration will be composed of the sum of the following components:

a. The remuneration for fuel
b. The remuneration for non-fuel variable costs, which includes the remuneration for variable costs of operation and maintenance, the remuneration for variable costs of additional operation and maintenance due to the start-ups and other operating costs of the plant.
c. The remuneration for costs of the CO_2 emission rights.

On the other hand, the remuneration for the fixed costs will be composed as follows:

$$FC_{y,i} = \min(A_{y,i}, \sum_{h=Y_i}^{h=X_i} AP_{i,h} * FC_{i,h,y}) \qquad \textbf{3.5)}$$

Where,

$FC_{y,i}$: Remuneration for fixed costs for group i in year y, expressed in euros.

$A_{y,i,}$: Annuity of the fixed remuneration of group i, in year y, expressed in euros.

$AP_{i,h}$: Available power of group i in hour h, expressed in MW.

$FC_{i,h,y}$: Remuneration for fixed hourly cost of group I, in hour h, of year y, expressed in € / MW.

X_i = Total number of hours of the year, which will take the value of 8.760 in normal year and 8.784 in leap year, except for the last year of regulatory life of group i. For that, X_i shall be the total number of hours from January 1st of that year to the day on which the regulatory life of group i is terminated.

Y_i= 1, except for the first year of remuneration for fixed costs of group i, which shall be the total number of hours from January 1st of that year to the day on which the regulatory life of the group begins.

The value of the remuneration by fixed hour cost for each group in a specific hour of a certain year will be calculated as follows:

$$FC_{i,h,y} = \frac{FC_{y,i}}{NP_i * H_i} * fsea_h \qquad \mathbf{3.6})$$

Where:

$FC_{i,h,y}$: Remuneration for fixed hourly cost of group i, in hour h, of year y, expressed in € / MW.

NP_i: Net power of group i in MW obtained from the administrative register of electrical energy production facilities of the Ministry of Energy, Tourism and Digital Agenda.

$FC_{y,i}$: Annuity of the fixed remuneration of group i, in year n expressed in euros.

$fsea_h$: Seasonality factor for each of the non-peninsular territories and for each time period, peak and valley.

H_i: Standard operating hours of group i, taking into account the standard annual failure and maintenance times of the group.

The annuity of the fixed remuneration of each group shall be calculated as the sum of an investment compensation term and a compensation term for fixed operating and maintenance costs, according to the following expression:

$$FC_{y,i} = AI_{i,y} + FO\&M_{y,i} \qquad \textbf{3.7)}$$

Where:

$AI_{i,y}$: is the annuity of the remuneration for investment of a group i, in year n, expressed in euros.

$FO\&M_{y,i}$: is the annuity of the remuneration for fixed operation and maintenance, in year n, of group i, expressed in euros.

The annuity of the investment remuneration consists of the remuneration for amortization and the financial compensation, and will be calculated according to the following formula:

$$AI_{i,y} = AInv_{i,y} + F_{i,y} \qquad \textbf{3.8)}$$

Where:

$AInv_{i,y}$: Compensation for amortization of the investment of group i, in year y, expressed in euros.

$F_{i,y}$: Financial remuneration in year n of the investment of group i, expressed in euros, to be calculated in accordance with the provisions of article 27.

Finally, the financial remuneration of the investment of each group i, $F_{i,y}$, expressed in euros, will be calculated each year y from the net value of the investment and the rate of financial compensation, according to the following:

a. For all the years of the useful life of the group with the exception of the first and last year:

$$F_{i,y} = VNP_{i,y} * AR \qquad \textbf{3.9)}$$

b. For the first and last year of the group's useful life:

$$F_{i,y} = VNP_{i,y} * [(1 + MR)^{month} - 1] \qquad \textbf{3.10)}$$

Being:

$VNP_{i,y}$: net present value of the investment of group i in year y, expressed in euros.

AR: allowed rate of return of the year n to be applied to the group during the regulatory period.

MR: Monthly rate equivalent to the annual allowed rate of return, which will be calculated by the following expression:

$$MR = (1 + AR)^{\frac{1}{12}} - 1 \qquad \textbf{3.11)}$$

$month$: In year 1, its value shall be equal to the number of full months from the beginning of the regulatory life of group i and 1st January of the year following the definitive registration in the administrative registry of electric power production facilities. In the last year of the regulatory life of the plant its value will be equal to the number of full months of that year that remain until the end of the "regulatory life" of the plant.

3.2.3. Remuneration to Smart Grids investments

Currently the regulatory framework in Spain does not recognize any particular remuneration for innovative investments or "smart grids". There is a regime for T&D activities (Orden IET/2660/2015) though that has established a 12 years "regulatory lifespan" for equipment related to the smart grids. This lifespan is shorter than the 40 years recovery length of most T&D equipment. This means that the smart grids assets will be considered in the RAB in the same way as any other T&D asset. There is no further detail with regards to the treatment of smart grids in the Spanish regulatory framework.

Chapter 4

4.State of the Art

In order to come up with an orthodox methodology for the estimation of the allowed rate of return, the analysis of the state of the art must be borne in mind.

First, a previous methodology proposed for T&D activities within a thesis work will be analyzed as a relevant precedent, in section 4.1. Then, a European benchmarking will be carried out in section 4.2. Lastly, the internal precedents in other sectors supervised by CNMC will be analyzed. In particular, the proposal to estimate the WACC in the airports´ industry will be presented as a recent and relevant internal precedent for CNMC.

4.1. Previous methodology proposed for T&D activities

This section will be devoted to describe the procedure for the methodology proposed by a previous thesis work (Fournier, 2016) for the transmission and distribution activities. This methodology will be used as the foundation for the methodologies proposed in this work, and moreover the objective of this work is to obtain comparable methodologies that can be used as a set for the next regulatory period. Basic elements of this previous methodology will remain unchanged and only in some specific sections some changes will be proposed to make the procedure specific to the different activities analyzed in this document. The procedure used for T&D includes four main stages. The first stage starts with the definition of common features which will be used to estimate the parameters of the WACC, for instance: source of data, period of study, investment horizon and definition of the peer group of utilities. The second describes two key parameters that are used in the estimation of following parameters: optimal gearing ratio and tax rate. Finally, last two sections propose a computation for the cost of equity and cost of debt, respectively.

4.1.1. Key steps to identify the relevant features of the methodology

Step 1: Identifying a suitable Peer Group of utilities

As it is stated in (Fournier, 2016), the identification of a suitable peer group of utilities is critical when proposing a methodology to approximate the allowed rate of return of a given industry. The correct choice of peer utilities will enhance the relevance of the methodology for the desired purposes. It is important to remind that the utilities of the peer group should have a similar risk-profile in order to correctly approximate the risk involved in the industry under research.

There are two main reasons explaining the necessity of a set of peer groups:

1. The quantity of electricity T&D utilities in a given country is not enough to carry out an exhaustive analysis (e.g. minimize the error of the analysis).
2. The methodologies to value the utilities, and therefore to value a given industry (e.g. T&D network industry in Spain) are based on market values. These market values are usually got from stock markets data; however; not all the utilities within a country are listed. Hence, the group of companies would not be sufficient to perform the required analysis.

Regarding the optimal number of utilities, (The Battle Group, 2014) argues that “there is a trade-off when determining the number of utilities in the peer group”. At first glance, it would be desirable to add as many utilities as possible to the peer group in order to reduce the statistical error in the estimate; however, as more peers are added, there is a risk to include non-related utilities to the group (e.g. different systematic risk).

On the other side, specific criteria must be defined beforehand regarding the characteristics of the utilities which are relevant for the study. These criteria (Fournier, 2016) will ensure the right choice of utilities in order to represent a similar systematic risk among utilities.

a. Relevant energy network industries: The methodology recognizes the similarities between the electricity and the gas networks at European level, such as their natural monopoly condition and the requirement of large investment for fixed assets; hence, both sectors were taken into account in the selection of the peer utilities despite the fact their regulatory framework might be different among both industries, and these differences should be addressed at a later stage when setting the allowed rate of return.

b. Relevant network activities: Contrary to the Spanish regulatory framework of previous regulatory periods, the current framework entails a methodology that does not make difference between transmission and distribution activities. Therefore, the peer group list will include both T&D utilities, while utilities performing only other activities – generation, retail, trading – should be excluded.

c. Relevant regulated network undertakings: The firms composing the peer group list are required to comply with a relevant level of revenues originated from regulated activities. The reasoning behind this statement relies on the fact that utilities performing regulated undertakings are proved to have a lower systematic risk than unregulated ones. (Norton, 1985)

d. Relevant size of network utilities: The current regulatory framework does not recognize any difference between large utilities and small utilities regarding the allowed rate of return. Therefore, the methodology aims to include both types of utilities into the peer group, although lack of market data from small utilities might result in non-inclusion.

e. Relevant regulatory framework: Spanish regulation clearly states the financing costs of comparable well-managed T&D European companies should be taken into account[5]. Moreover, the risk-profile of network utilities is usually constrained by the regulatory framework in which they operate; therefore, peer utilities are required to operate in a similar regulatory framework as a mean of connection among them. The suggestion of this methodology entails the selection of peer utilities belonging to countries under the regulatory framework of the EU due to its relevancy and its enforcement in Spain. Additionally, it is assumed that EU members share a similar strategic vision regarding energy matters due to their interdependency among member states. For this reason, countries with different regulatory framework should not be considered into the peer group.

f. Relevant region: Spanish economy shares many similarities with Western European countries; hence, only this region will be considered in the selection of peer utilities. However, this methodology is intended to focus only on those countries with relevant size since investments on the electricity system are impacted by the total area where they are built; therefore, countries with smaller area to 20,000 km^2 should be not be included into the peer group.

g. Relevant economic situation: Utilities belonging to countries with an economic situation that roughly differs from the Spanish's should not be taken into account. The proposed measurement from this criterion is through countries' ratings. Then, countries with worse ratings than "BB- / Ba3" – depending on the scale – should be excluded from the peer group.

h. Relevant market data: As previously explained, market data are usually obtained from stock market sources (e.g. Bloomberg). However, data availability might also constraint the methodology. Therefore, utilities with insignificant market data should be excluded from the peer group.

The methodology (Fournier, 2016) includes companies belonging to the **STOXX® Europe TMI Utilities Index**. This index is mostly composed by utilities from Western Europe (and Czech Republic) from different sectors; hence, not only energy utilities are included in the index and therefore utilities from other sectors have to be identified and excluded. Moreover, the peer group of the proposed methodology was enriched by adding utilities that were not included in the abovementioned stock index but that might be relevant for the research. These supplementary utilities were obtained throughout a filtering data process in Bloomberg based on the **Product Segments of the utilities**; the process followed is down below:

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[5] Article 14 of Royal Decree 1047/2013

EQS: Equity Screening function

> *Product Segments*: Utilities

>> *Utilities Networks*: Electricity Distribution + Electricity Transmission + Gas Distribution + Gas Transmission and Storage

>>> *Latest FY Product Segment Revenue Percent:* Greater than or equal to 0.1

>>>> *Country of domicile*: Western Europe (except: Andorra, Cyprus, Faeroe Island, Gibraltar, Guernsey, Isle of Man, Jersey, Liechtenstein, Luxembourg, Malta, Monaco, Reunion, San Marino, Svalbard and Jan Mayen Islands, Switzerland).

Next step consisted in the evaluation of each utility in order to determine their fulfilment with the abovementioned criteria (subparagraphs a. to h.); utilities complying with the totality of such criteria remained in the Final peer group; on the contrary, any utility failing any criterion was removed from the list.

Two conclusions might be roughly drawn from this process: 1) Greece was the only country – from the Provisional peer group of utilities – which did not comply with the criterion "g. Relevant economic situation" since its credit rating was below the threshold proposed (see Table 5.6); and, 2) there are utilities which failed with more than one criterion (e.g. Terna Energy S.A).

Table 8. Utilities excluded from the Final peer group of utilities

Peer utility	Country	Reason of exclusion
ABENGOA YIELD PL	Spain	b. No regulated network activity
ANDES ENERGIA PL	United Kingdom	e. No relevant activity within the region
AREVA SA	France	b. No regulated network activity
BEGASA	Spain	h. No relevant market data
CENTRICA PLC	United Kingdom	b. No regulated network activity
CEZ AS	Czech Republic	e. No relevant activity within the region
COMPAGNIE PARISIENNE DE CHAUFFAGE	France	b. No regulated network activity h. No relevant market data
DRAX GROUP PLC	United Kingdom	b. No regulated network activity
EDP RENOVAVEIS SA	Portugal	b. No regulated network activity
ELECTRICITÉ DE STRASBOURG	France	a. No energy industry b. No regulated network activity
ENEL GREEN POWER SpA	Italy	b. No regulated network activity
ESTABANELL I PAHISSA	Spain	h. No relevant market data
EYDAP SA	Greece	a. No energy industry g. Country with low rating profile
FINTEL ENERGIA GROUP	Italy	h. No relevant market data
FORTUM OYJ	Finland	b. No regulated network activity
GALA SpA	Italy	b. No regulated network activity
GELSENWASSER AG	Germany	a. No energy industry
JERSEY ELECTRICITY	United Kingdom	h. No relevant market data e. No relevant activity within the region
LUXFER HOLDINGS	United Kingdom	a. No energy industry
MADRILEÑA RED DE GAS	Spain	h. No relevant market data
MAINOVA AG	Germany	h. No relevant market data
PENNON GROUP PLC	United Kingdom	a. No energy industry
PUBLIC POWER CORP	Greece	g. Country with low rating profile
REDEXIS GAS	Spain	h. No relevant market data
RUBIS SCA	France	b. No regulated network activity
SEVERN TRENT PLC	United Kingdom	a. No energy industry
SUEZ ENVIRONNEMENT CO	France	a. No energy industry
SUMINISTRADORA ELÉCTRICA DE CADIZ SA	Spain	h. No relevant market data
TERNA ENERGY SA	Greece	b. No regulated network activity g. Country with low rating profile
THESSALONIKI WATER SUPPLY & SEWAGE CO SA	Greece	a. No energy industry g. Country with low rating profile
UNITED UTILITIES GROUP PLC	United Kingdom	a. No energy industry
VEOLIA ENVIRONNEMENT SA	France	a. No energy industry
VIESGO DISTRIBUCIÓN ELECTRICA SI	Spain	h. No relevant market data

As a result of the previous analysis, the Final peer group (Fournier, 2016) was obtained resulting in a total of 30 utilities (see Table 5.8). It is noteworthy that most of the peer utilities belong to either one of the two main European energy groups of utilities – ENTSO [6] or EDSO for smart grids, which suggests the relevancy of these utilities in the European framework. Moreover, the country which contributes with more utilities to the final list is Italy (10 utilities), followed by Spain (5 utilities) and Germany (3 utilities). Lastly, it is remarkable that 17 out of the 30 utilities belong to the so-called "Southern peripheral economies"[7] in the Eurozone (Spain, Portugal, and Italy); then, it can be concluded that the proposed methodology leads to a Final peer group of utilities which is a good proxy to the current Spanish economic situation.

Table 9. Final peer group of utilities

Utility	Country	ENTSO / EDSO
A2A SpA	Italy	-
ACEA SpA	Italy	-
ACSM - AGAM SpA	Italy	-
ASCOPIAVE SpA	Italy	-
E.ON SE	Germany	EDSO
EDF - Électricité de France SA	France	ENTSO
EDP - Energias de Portugal SA	Portugal	EDSO
ELIA SYSTEM OPERATOR SA	Belgium	ENTSO
ELVERKET VALLENTUNA AB	Sweden	-
ENAGAS SA	Spain	ENTSO
ENDESA SA	Spain	EDSO
ENEL SpA	Italy	EDSO
ENGIE SA	France	-
EVN AG	Austria	EDSO
FLUXYS BELGIUM	Belgium	ENTSO
GAS NATURAL SDG SA	Spain	EDSO
GAS PLUS	Italy	-
HAFSLUND ASA SHS	Norway	-
HERA SpA	Italy	-
IBERDROLA SA	Spain	Both
IREN SpA	Italy	-
LECHWERKE AG	Germany	-
NATIONAL GRID PLC	Great Britain	ENTSO
RED ELECTRICA CORP SA	Spain	ENTSO
REN - Redes Energéticas Nacionais	Portugal	ENTSO
RWE AG	Germany	EDSO
SNAM SpA	Italy	ENTSO
SSE PLC - Scottish & Southern Energy	Great Britain	ENTSO
TERNA SpA - Terna Rete Elettrica Nazionale	Italy	ENTSO
VERBUND AG	Austria	ENTSO

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[6] For the sake of simplicity, the term "ENTSO" is used indifferently for both ENTSO-e and ENTSO-g

[7] See: http://www.cnbc.com/2014/10/21/are-these-countries-the-new-pheriphery-in-europe.html

Apart from the aforementioned analysis, the methodology (Fournier, 2016) conceived a supplementary analysis based on a peer group composed by utilities performing only energy regulated activities (also known as “Pure utilities”). Taking the Table 5.8 as base, only pure utilities were kept in order to build the Final peer group of pure utilities (see Table 10).

Table 10. Final peer group of pure utilities

Utility	Country	ENTSO
ELIA SYSTEM OPERATOR SA	Belgium	X
ENAGAS SA	Spain	X
FLUXYS BELGIUM	Belgium	X
NATIONAL GRID PLC	Great Britain	X
RED ELECTRICA CORP SA	Spain	X
REN - Redes Energéticas Nacionais	Portugal	X
SNAM SpA	Italy	X
TERNA SpA - Terna Rete Elettrica Nazionale	Italy	X

A total of 8 utilities were found performing only-regulated activities in either energy sector (gas or electricity). The selection procedure involved an exhaustive and complete analysis of all utilities included in the Final peer group of utilities; hence, utilities carrying out liberalised activities (generation, retailing, wholesale, etc.) were excluded from this complementary peer group.

Results from this additional analysis shall be expected to suggest a lower allowed rate of return than results obtained from the main analysis (Final peer group of utilities - 30 utilities); this is supported by the fact that pure utilities have lower risk than non-pure utilities.

Step 2: Identifying the relevant periods of study

The period of study refers to the term used when getting the observations; therefore, the selection of this parameter influences the result of the overall research since important assumptions must be defined during this stage.

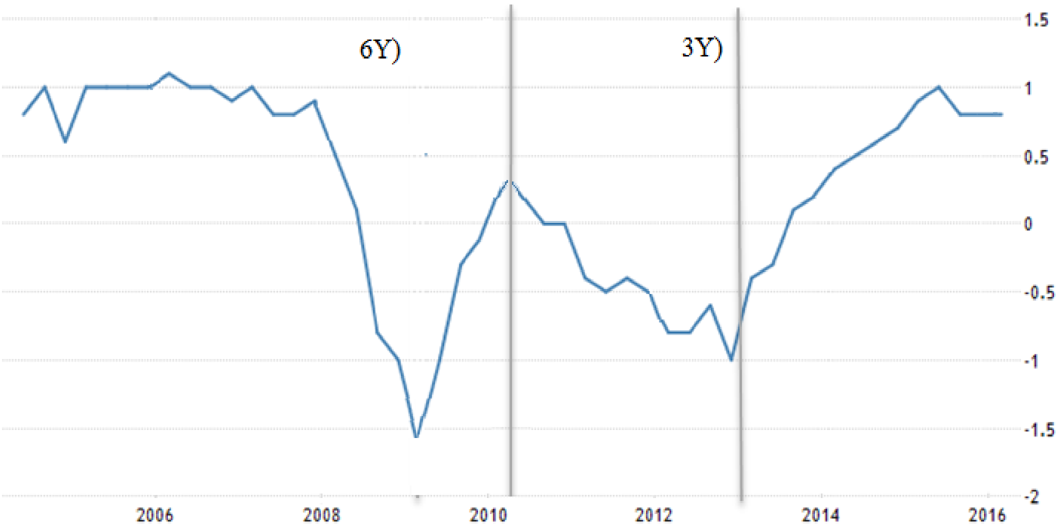
Table 11. Analysis of the proposed study periods

			Overview	GDP growth rate (%)			
				Mean	Max	Min	Spread
Period of study	1 year	2015-2016	Medium stability	0,85	1,0	0,8	0,2
	3 years	2013-2016	Recovery trend	0,55	1,0	-0,3	1,3
	6 years	2010-2016	Downwards - Upwards	0,01	1,0	-1,0	2,0
	12 years	2004-2016	High stability - Crisis - Recovery	0,20	1,1	-1,6	2,7

The availability and completeness of data constraints the selection of the period of study given that insufficient data might jeopardize the analysis and lead to statistical errors. It is also important to highlight that the methodology by (Fournier, 2016) considers data until 29/April/2016. Periods of time were also adapted to this date; for instance, a 1-year period included data from 29/April/2015 to 29/April/2016.

Inferences regarding the data of each period can be drawn. For example, the 6-year period gives the impression to be the one with the worst economic performance (lowest GDP growth rate mean); however, it also suggests being the most prudent scenario since it considers both downwards and upwards trends.

On the other side, 1-year period shows a more stable environment (lowest spread between maximum and minimum observation); this can be explained since no downturns in the economy are found within this period (see Figure 5.2)[8]. Nevertheless, this period of study seems to suggest an extremely positive scenario – assuming constant stability and no negative economic growth – for the upcoming years (next regulatory period), with some of the parameters that take part in the WACC formula at their lowest levels of the past 10 years.



Source: Trading economics

Figure 6. GDP growth rate (%) in Spain (2004-2016)

With this in mind, two periods of study ended up being irrelevant for the proposed methodology (Fournier, 2016):

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[8] http://es.tradingeconomics.com/spain/gdp-growth

1. 12-year period has incomplete data for the most relevant parameters of the methodology; therefore, assuming that missing data of this period might lead to errors in the estimation, it is not recommended to use this period of study for the purposes of this methodology.
2. 1-year period shows an optimistic scenario in which nowadays economic conditions are kept forward; additionally, it is not well linked with the 6-year period of application of the allowed rate of return (the purpose of this methodology).

Step 3: Identifying the relevant frequency of observations

The frequency of observations refers to the regularity that observations are taken within the period of study selected. Therefore, a highly frequency (daily data) comprises more observations which enhance the statistical analysis; however, the availability of data might be a problem.

Regarding the methodology proposed by (Fournier, 2016), four different frequencies were analyzed; they can be inferred from: Daily, Weekly, Monthly and Yearly. The methodology suggests the exclusion of Yearly frequencies based on the few observations that can be retrieved. However, for some parameters – mainly those related to book values – the use of yearly data would be required, in order to ensure the availability of audited data.

Lastly, researches about this topic supports the use of weekly frequencies as an appropriate feature for most of the WACC parameters; for example, (The Battle Group, 2014) argues that “using weekly returns to calculate the beta mitigates the problem of not correlation between firm’s value and the market; since it is more likely that firm’s shares will be traded in the week. However, using weekly returns have other disadvantages, such as providing fewer 80% less data point over any given period”. The relevant frequency of observations suggested by (Fournier, 2016) is the following:

Parameters	**Relevant frequency**
Gearing ratio	Quarterly
Sovereign Bonds	Daily
IRS	Daily
Betas	Daily
CDS	Daily
Utilities Bonds	Issue date
Debt records (Book values)	Yearly

Figure 7. Relevant frequencies based on the nature of the parameters

Step 4: Identifying the relevant horizon

Market instruments with a maturity around 8-12 years will be preferred over the rest; specifically, instruments with horizon of 10-year will be primarily sought.

The reasons that justify this decision are explained as following (Fournier, 2016) : 1) 10-year horizon is related with the expected horizon of medium-long term investors (e.g. investors of network industries); 2) the use of this horizon is a common practice among European regulators; 3) market liquidity of instruments with this horizon is appropriate enough in order to reflect the right market value of the financial instruments (Gandolfi, 2009); and 4) this horizon is in line with the methodology to estimate the allowed rate of return according to the Spanish regulation. Table 5.13 shows the relevant horizon for some market instruments – according to investor's horizon – that will be later introduced.

Table 12. Relevant horizons of some market instruments

Instrument	Relevant horizon
CDS - Credit Default Swaps	10 years
Utilities' Bonds	8-12 years
Sovereign Bonds	10 years
ISR - Interest Swap Rate	10 years

Step 5: Identifying the relevant source of information

Market values shall be preferable over book values. Additionally, as it can be inferred from previous sections, the use of Bloomberg – as the main source of data – will be a key feature of the present research. Finally, data available from public sources was also used in order to include information that Bloomberg might not include (e.g. financial reports of non-listed utilities).

4.1.2. Defining the general parameters

Optimal gearing ratio

The methodology proposed by (Fournier, 2016) tries to find consensus between the use of market values (it is usually supposed that companies seek to optimize their leverage, so using market values should be enough to get the optimum value) and regulated defined values to set the optimal gearing ratio.

First, the observed gearing ratios for the peer group of utilities were estimated. Data were obtained from market values, taking into account that the market capitalization represents the equity of the company, while the Net Debt is computed as the difference of Total Debt minus Cash and Cash equivalents. Gearing ratio refers to the proportion of the Net Debt over the Net Debt plus Market capitalization; therefore, a gearing ratio for each peer utility was found. However, atypical values were detected (e.g. negative ratios) so the “two standard deviation approach”[9] was applied in order to remove those outliers; finally, the average of the remaining ratios was obtained (see **Equation 4.1**).

$$\frac{\sum_{\forall\, ut} \frac{Net\ debt_{ut}}{Net\ debt_{ut} + \ Market\ cap_{ut}}}{\#\ utilities} \qquad \mathbf{4.1})$$

It is important to highlight that this formulation implies the same weight to all the peers; however, an alternative method was also explored by (Fournier, 2016) . **Equation 4.2** recognizes the different weights of all the utilities; therefore, data of small utilities does not have a significant impact on the overall result.

$$\frac{\sum_{\forall\, ut} \quad Net\ debt_{ut}}{\sum_{\forall\, ut} \quad Net\ debt_{ut} + \ Market\ cap_{ut}} \qquad \mathbf{4.2})$$

Finally, these two formulations were also performed for the peer group of pure utilities. The methodology by (Fournier, 2016) provides results for the three relevant periods of study (see Section 5.2.1)

Table 13. Results of observed gearing ratios of peer group of utilities

Observed gearing ratios				
	Peer utilities		**Pure-peer utilities**	
	Equation 1	Equation 2	Equation 1	Equation 2
1 year	45%	47%	47%	44%
3 years	47%	48%	48%	46%
6 years	49%	50%	51%	48%
12 years	Not relevant			

Regulatory precedents

On a final step, the observed range (45%-50%) was compared against the European regulatory precedents[10] (see Table 5.15). As it can be noted, the observed values are lower than those used by most of European regulators (55%-60%). Therefore and for the sake of coherency with the European standards, the proposed methodology by (Fournier, 2016) suggests going for the upper value of the observed range (50%) in all the cases.

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[9] Utilities with values above or below two standard deviations were removed

[10] Based on (CEER, 2016)

Table 14. Gearing ratios used by the European regulators - CEER

Country	Gearing ratio	Year	Regulatory period
Austria	60%	2012	5
Germany	60%	2011	5
Finland	60%	2012	4
NL	55%	2010	3
Ireland	55%	2010	5
Italy	44%	2012	4
Portugal	55%	2015	-

Source: CEER

Tax rate

Two alternatives can be used when selecting the tax rate to be applied in the WACC methodologies: 1) Effective tax rate (observed values from peer utilities), or 2) Statutory tax rate (according to the current legislation). However, after the analysis of several methodologies, it was found that the statutory tax rate is typically used as a parameter in the WACC computation.

Also, the use of the effective tax rate was not taken into account in order to allow companies to retain the tax benefits derived from their fiscal strategies. Moreover, there is no optimal effective tax rate to be paid, so it would make no sense to force other companies to pursue a given fiscal strategy. Thus, the statutory tax rate that has more relevance to the approximation of the allowed rate of return for regulated network utilities is the “Corporate income tax rate”.

4.1.3. Cost of equity

The proposed methodology by (Fournier, 2016) is based on the CAPM model like almost all European regulators do; moreover, this approach is also in line with the jurisprudence used by the CNMC in other sectors. This model is composed by the RFR, CRP, Beta and MRP. These parameters will be explained in subsequent sections.

Risk free rate (RFR)

The methodology recommends the simple average yield of the 10-year Spanish government bond based on daily observations as the best alternative to approximate the Risk free rate of investors. This approach (Approach 1) already takes into consideration the Country Risk Premium of Spain. Depending on the selected period of study, the values of the proposed RFR varies within a range of 1.80% and 3.97%. It is important to note that 6-year period displays the higher figure since it comprises some years of the financial and economic crisis.

Table 15. Average nominal yields of 10-year sovereign government bonds

		Spain	**Germany**	**Netherlands**	**Finland**	**Austria**
1 year	Mean	1,80%	0,53%	0,70%	0,73%	0,78%
	Std Dev	0,23%	0,22%	0,23%	0,17%	0,23%
3 years	Mean	2,64%	1,00%	1,23%	1,19%	1,27%
	Std Dev	1,11%	0,57%	0,66%	0,61%	0,64%
6 years	Mean	3,97%	1,57%	1,84%	1,81%	2,01%
	Std Dev	1,62%	0,84%	0,89%	0,89%	0,98%
12 years	Not relevant					

Country Risk Premium (CRP)

An additional approach (Approach 2) can also be followed; thus, the CRP shall be separated from the RFR in order to understand both values in a more comprehensible way. However, it will be demonstrated that both approaches bring up to the same outcome.

Following this approach (Approach 2) and according to the theoretical definition of risk free rate, the RFR should be represented by pure risk free assets in the market, in this case it refers to those rated-AAA countries in the Eurozone (Germany and Netherlands)[11] – as other peripheral countries do. Therefore, the simple average yields of the 10-year German and Dutch government bonds shall be approximated.

On the other side, the CRP is normally estimated as the spread between the AAA countries with respect to the Spanish bond. Later, spread between Spanish bond and average of German and Dutch government bonds is computed. According to Table 5.18, the spread (CRP) ranges between 1.19% and 2.26%, depending on the period of study selected.

Table 16. Comparison of RFR approaches

	Approach 1	**Approach 2**		
	RFR	RFR	CRP	RFR + CRP
	Spain	AAA countries	Spain - AAA Spread	
1 year	1,80%	0,61%	1,19%	1,80%
3 years	2,64%	1,12%	1,53%	2,64%
6 years	3,97%	1,71%	2,26%	3,97%
12 years	Not relevant			

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[11] Only these two countries are rated-AAA by the 3 rating agencies: Moody's, S&P and Fitch

Finally, it is observed that results from both Approach 1 and Approach 2 are exactly the same (see Table 5.18). It is possible to conclude that the selection of any approach does not represent any change. Therefore, (Fournier, 2016) argues that Approach 1 is still preferred over Approach 2 due to its simplicity.

Beta coefficient

The beta coefficient based on universally known financial sources (e.g. Bloomberg) was selected. Additionally, beta of the Spanish energy network industry cannot be measured directly due to the scarcity of listed Spanish pure-utilities; thus, the peer group of utilities obtained in Step 1, will be useful in order to determine a proxy of the beta of this industry.

The regression for each utility was built by (Fournier, 2016) based on weekly observations of their shares with respect to their local indices. Moreover, the unlevered beta for the industry was estimated throughout the mean value of unlevered betas from the peer group; and finally, that value was later re-levered using an optimal gearing ratio of 50% and the Spanish statutory tax in 2016 (25%). Results are shown in Table 5.20.

Table 17. Example of levering process applied to the peer group of utilities

Peer utility	Reference index	Country	Tax	Leverage ratio (D/E)	Levered beta *	Unlevered beta **
EDF - Électricité de France SA	CAC	France	34%	1,59	1,05	0,51
EDP - Energias de Portugal SA	PSI20	Portugal	28%	1,47	0,92	0,45
ENDESA SA	IBEX	Spain	25%	0,25	0,54	0,45
ELIA SYSTEM OPERATOR SA	BEL20	Belgium	33%	1,09	0,37	0,21

* Raw beta from regression

** After Modigliani – Miller formula

Finally, it is important to highlight that no Bayesian adjustment was performed. It was found that such adjustment is not used by the European regulators (based on the benchmarking analysis); more importantly, some methodologies (e.g. Ireland) considered such adjustment as arbitrary and inappropriate.

Table 18. Betas of the industry based on peer group of utilities

Period	Levered beta	Unlevered beta	Re-levered beta	Optimal gearing ratio	Relevant tax
1 year	0,53	0,33	0,57	50%	25%
3 year	0,58	0,35	0,61		
6 year	0,63	0,37	0,64		
12 years		Not relevant			

Market Risk Premium (MRP)

To measure the MRP, historical analysis is preferred over expectations polls since it is the most frequently approach used by the regulators; this statement is supported after the analysis carried out to the Report of Investment Conditions (CEER, 2016). The methodology proposed by (Fournier, 2016) suggest using the DMS (Credit Suisse, 2016) report. The midpoint between the geometric mean and the arithmetic mean of the historical values is used. This approach was used by Germany and Netherlands by arguing lack of reasons to focus on either alternative (Arithmetical vs geometrical means).

Table 19. Pool of alternatives for the MRP

Source	Year	Spain	Weighted European
DMS - Geometric mean	1900-2013	2,20%	3,66%
DMS - Avg. Arithmetic & Geometric	1900-2013	3,20%	4,85%
DMS - Arithmetic mean	1900-2013	4,20%	6,05%
Pablo Fernandez - Surveys	2016	6,20%	5,49%
Damodaran - CDS	2016	7,71%	7,93%

Source: Several sources

Finally, the selection of either the Spanish or the European DMS data is a matter of relevance. The former one refers to the market premiums observed in Spain while the latter approach refers to the average of European countries[12]; however, the European approach can also be understandable throughout two methods: 1) the single average of European countries and 2) the weighted average of European countries based on their relative size. The latter approach was considered more suitable for the methodology proposed by (Fournier, 2016), so it was selected among these two options.

Regarding the Spanish and European approach, the selection will depend upon the assumptions regarding the expected investors on the Spanish framework; however, based on other countries' regulations and the globalization, the European approach would be advisable since global investors would probably base their investments decisions on network utilities at European level.

4.1.4. Cost of debt

Normally the debt assets with the lowest default risk are those belonging to governments, followed by the banks and then the utilities. The report shows that German reality complies with this concept: the German government is getting financed cheaper than banks– presented by the Interest Swap Rate – and utilities– represented by their debt issuances. Please note that these three asset rates are based on a (long-term) 10-year horizon.

However, the current reality in the Spanish context (as other countries) is not consistent with the economic theory since it has been observed that – since 2010 – Spanish utilities have been getting financed cheaper than the Spanish government in debt markets. The methodology proposed by Fournier (2016) suggests two approaches regarding the estimation of the cost of debt: Approach 1:

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[12] According to the criteria used in the selection of the peer group of utilities (European Union + Norway)

The average yield at issue of debt bonds belonging to the peer group of utilities; and Approach 2: The sum of a risk free rate plus a debt premium. Later, results from these approaches will be compared against 3 additional debt references: European benchmarking and book values.

Approach 1: Debt bonds of peer group of utilities

Companies listed in stock markets are able to issue debt bonds as a way of raising funds; the yield at issue (internal rate of return at issue date) of these bonds represent straightforwardly the cost at which utilities are getting financed in debt markets.

Although the issuance of debt bonds is a really common practice among companies[13] and despite the fact that some regulators use this approach in their methodologies, the analysis of debt throughout debt issuances has a couple of drawbacks to take into account: a) they are discrete subjective events which are highly influenced by the financial strategies of companies (they decide the most appropriate time when issuing debt), and b) debt bonds are issued at unstandardized horizons (different maturities).

Analysis of Approach 1 by Fournier (2016) was based on debt bonds issued by the peer group of utilities for every period of study. Criteria used at the selection of bonds are explained as following:

a. Issuer: Bonds issued by both the parent company of the peer utilities, and its subsidiaries were taken into account.
b. Date: Bonds issued until 29/April/2016 (in accordance with the period of study).
c. Region: Bonds issued in countries different from Western Europe were excluded in order to be coherent with the criteria used in the selection of the peer group of utilities (see Section 5.2.1).
d. Currency: Corporate bonds issued only in euros (€) were taken into account; then, bonds in other currencies were excluded.
e. Maturity: Bonds with a 10-year horizon were taken into account; hence, bonds with a maturity falling outside the 8-12 years range were excluded.
f. Companies rating: Corporate bonds with a lower credit rating[14] than the Spanish rating were excluded. Four utilities were found within this circumstance:
    - A2A SpA
    - EDP – Energias de Portugal SA
    - REN – Redes Energeticas Nacionais
    - RWE AG

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[13] Bonds from 26 utilities out of 30 (from the peer group of utilities) were obtained

[14] Due to the existence of rating discrepancies between the 3 universally recognized rating agencies (Moody's, S&P and Fitch), the 2/3 criteria was used when comparing ratings. In other words, 2 out 3 credit ratings must not be lower than the Spanish one.

g. Bond rating: Quality of bonds is also measured through credit ratings; therefore, previous criterion was applied to each bond: bonds with a lower credit rating than the Spanish one were excluded (no matter if the company by itself complies with the rating criteria).

h. Completeness of information: Three cases regarding incomplete information were found: companies without bonds, companies without credit rating[15], and bonds without information about yield at issue. Bonds falling in one of these circumstances were excluded.

After collecting the relevant bonds – based on the previous criteria – the average yield at issue for each period of study was computed by Fournier (2016). Moreover, taking into account the 12-year period (only for reference purposes), there were found 79 debt bonds belonging to 18 utilities from the peer group of utilities. The average yield from the total bonds is 3.22%; the maximum yield at issue is 6.53% belonging to ENGIE SA (France) and issued in October 2008, while the minimum is 1.01% issued also by ENGIE SA (France) but 6 years after (March 2015).

Table 20. Summary of corporate bonds issued by the peer group of utilities

Period	**1 year**		**3 years**		**6 years**		**12 years**	
#	13		39		59		79	
Avg. Yield		1,47%		1,88%		2,62%		3,22%
Std. Dev.		0,30%		0,68%		1,27%		1,54%
Max		2,16%		3,37%		5,44%		6,53%
Min		1,14%		1,01%		1,01%		1,01%
Germany	0	-	0	-	0	-	2	5,50%
Sweden	0	-	0	-	1	4,23%	1	4,23%
Austria	0	-	1	1,65%	1	1,65%	1	1,65%
UK	1	1,67%	2	2,08%	2	2,08%	2	2,08%
Belgium	4	1,64%	4	1,64%	5	2,09%	5	2,09%
France	2	1,37%	6	1,78%	14	2,72%	19	3,38%
Spain	4	1,36%	17	1,75%	23	2,41%	30	3,01%
Italy	2	1,34%	9	2,28%	13	3,14%	19	3,61%
Portugal	0	-	0	-	0	-	0	-

Finally, results were disaggregated by country in order to perform a deeper analysis regarding their cost of debt. It can be roughly concluded that – in average – Spanish utilities are getting financed cheaper than utilities from remaining countries; however, it is important to highlight that more than 1/3 of the bonds in each period were issued by Spanish utilities.

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[15] Fluxys Belgium was excluded because this reason.

Approach 2: RFR + Debt Premium

Summing a RFR asset and a debt premium is a common practice among regulators when estimating the cost of debt. Results from the research by (Fournier, 2016) suggest the estimation of debt premium in two ways: 1) CDS of peer utilities, or 2) Spread between Spanish utilities bonds and AAA-countries utilities bonds. From these two alternatives, the latter one was dismissed since it was not possible to approximate a trustworthy spread due to the lack of significant bonds from AAA-countries' utilities[16] (see Table 5.23). Thus, the first alternative – approximation of the cost of debt through CDS – was deeply analyzed. According to this approach, the RFR is computed from the 10-year Interest Rate Swap, while the debt premium is obtained from the 10-year CDS from the peer group of utilities.

Regarding the first parameter, the Interest Rate Swap (IRS) could be understood as the interbank rate at which banks got financed among themselves; however, this rate cannot be applied straightforwardly to utilities since they are riskier entities than banks. Henceforth, an appropriate spread representing this additional risk is required. In relation to the second parameter, the Credit Default Swaps (CDS) represent the hedging cost of investors derived from the credit risk exposure involved when acquiring debt (the higher the credit risk, the higher the hedging cost). So it can be concluded that the cost of debt of a company is directly related to its credit worthiness, and this could be approximated through the cost of its CDS (the higher the credit worthiness, the lower the CDS cost). Finally, it can be concluded that CDS are a good proxy of the debt premium that companies need to offer to their financial lenders (the lower the CDS cost, the lower the debt premium).

As stated by (Fournier, 2016), an important advantage concerning this approach (Approach 2) compared to the Approach 1 refers to the fact that IRS and CDS are continuous measurements which can project estimations at any period of time and they are not influenced by the subjective decisions derived from financial strategies, additionally, horizons regarding these assets are normally standardized (1-year, 5-year, 10-year). On the other hand, there are some drawbacks that need to be highlighted: a) the market of CDS is mainly composed by big utilities with a liquid level of debt issuances; hence, only few companies among the peer group of utilities (11 utilities[17] out of 30) have CDS[18]. Additionally, although the liquidity of CDS is not questioned, it is noteworthy that CDS 5-year horizon is more liquid than CDS 10-year.

Criteria used at the selection of CDS were similar to the ones used in the selection of bonds:

a. Currency: CDS issued in euros (€) were taken into account.

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[16] Germany, Sweden and Austria

[17] Although 2 utilities were dismissed due to not compliance with rating criteria

[18] CDS with a 10-year horizon

b. Companies' rating: CDS belonging to utilities with a lower credit rating[19] than the Spanish rating were excluded. The same four utilities abovementioned were found within this circumstance. However, only two utilities were relevant (EDP – Energias de Portugal SA, and RWE AG) since the other two did not have CDS.

c. Completeness of information: Two cases regarding incomplete information were found: companies without CDS and CDS without updated information. CDS falling in one of these circumstances were excluded.

Table 21. Summary of both approaches (Cost of debt)

	Approach 1	**Approach 2**			**Mid-point**
	Corporate bonds	RFR IRS 10Y	Debt premium CDS 10Y	IRS + CDS	Average
1 year	1,47%	0,88%	1,16%	2,04%	1,76%
3 years	1,88%	1,30%	1,19%	2,49%	2,18%
6 years	2,62%	1,91%	1,48%	3,39%	3,00%
12 years	Not relevant				

Finally, results from both approaches regarding the cost of debt are summarized in Table 5.25. As it can be observed in the graph, corporate bonds issued by the utilities are really close to the IRS+CDS approach; therefore, it can be concluded that both approaches might be complementary among themselves.

For instance, taking as reference the 3-year period, the cost of debt – according to both approaches – ranges between 1.88% and 2.49%; the spread between lower and upper bound is around 0.70%. Thus, (Fournier, 2016) suggests taking the mid-point of these two values as the cost of the debt of the industry (2.18%).

Reference values

A supplementary analysis was conducted by (Fournier, 2016) based on the book values from the peer utilities, to be taken only as reference values.

Data were mainly obtained from Bloomberg and corporate annual reports. Cost of debt was computed by dividing 1) Interest expense over 2) Total debt. Due to lack of information, the collection of data of interest expense was based on the "Best available data" as explained as follows: first, the Interest Expense (IS_INT_EXPENSE) was sought after, if the value was not available – according to Bloomberg standards – then, the Total Interest Expense[20] (TOT_INT_EXP) was taken; the difference

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[19] Same criterion (2/3) was used when comparing ratings

[20] Total Interest Expense = Interest Expense + Capitalized interest

between these two functions is that the latter one includes the capitalized interests. Once the cost of capital for every peer utility was found, the average of the industry was estimated; nevertheless, similar criteria were taken into account when selecting the appropriate companies that represent the cost of debt of the industry:

a. Companies' rating: Data belonging to utilities with a lower credit rating[21] than the Spanish rating were excluded.
b. Completeness of information: Two cases regarding incomplete information were found: companies without credit rating and companies without information. Utilities falling in one of these circumstances were excluded.

Additionally, it is interesting to note that Spanish utilities cost of debt (based on book values) is in line with the other analysed countries.

Table 22. Summary of cost of debt of peer group of utilities (based on book values)

Period	1 year		3 years		6 years		12 years
# utilities	15		15		15		Not relevant
Avg. Yield		3,84%		3,86%		4,02%	
Std. Dev.		1,33%		1,26%		1,45%	
Max		5,71%		6,58%		7,17%	
Min		1,59%		1,96%		2,14%	
Austria	1	5,56%	1	4,83%	1	4,81%	
Sweden	1	5,38%	1	4,83%	1	4,58%	
Belgium	1	3,36%	1	3,89%	1	4,33%	
France	2	3,04%	2	3,71%	2	3,96%	
Spain	5	3,98%	5	3,95%	5	4,37%	
Italy	5	3,46%	5	3,43%	5	3,36%	

Regulatory precedents

Finally, reference values from the European benchmarking were also taken into account by (Fournier, 2016).

Table 23. Cost of debt applied by the European regulators - CEER

Country	Year	RFR	Year	Debt Premium	Cost of Debt
Austria	2013	1,25%	2013	1,45%	2,70%
Germany	2010	2,24%	real costs		-
Finland	2015	0,69%	2012	1,69%	2,38%
Ireland	2010	1,90%	2010	1,20%	3,10%
Italy	2014	2,56%	2012	0,45%	3,01%
NL	2010	2,36%	2010	1,50%	3,86%
Portugal *	2014	2,41%	2015	2,00%	4,41%

** Portugal: Nominal RFR*

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[21] Same criterion (2/3) was used when comparing ratings

4.2. European Benchmarking

One of the main propositions of this thesis is related to a benchmarking analysis of other methodologies to approximate the allowed rate of return for the different object of this thesis (throughout the estimation of the WACC). The criteria to perform this analysis were based on the following three principles:

1) According to previous experience: As earlier introduced, a methodology to compute the allowed rate of return for distribution utilities based on the WACC for T&D suggested by Fournier (2016) was analyzed.
2) According to regulator's jurisprudence: Methodologies to approximate the allowed rate of return by CNMC in different sectors are preferred to be coherent among them. Hence, a benchmark analysis of the methodology applied in the airport sector in 2016 will also be a main feature at this stage.
3) According to regulation: The proposed allowed rate of return has to be equivalent to the weighted average cost of capital of efficient and well-managed companies in Spain and the European Union; therefore, this thesis aims to understand the methodologies that other European regulators use when estimating the rate of return considered for remuneration of RES generation, generation in isolated energy systems and a possible smart grid approach.

The selection of the suitable countries for the benchmarking analysis is by no means a straight forward process. In first place, remuneration of RES differs from every country and therefore it is not possible to get a direct benchmark. Provided that the nature of this report is financial, the risk involved in the business of RES generation will be the main driver when choosing an appropriate benchmarking rather than the specific support schemes used in this industry. With that consideration in mind, two international regulatory frameworks have been chosen regarding RES remuneration. In first place the United Kingdom scheme will be presented and afterwards a European Report on WACC to RES by DiaCore (2016) will be discussed.

In second place, regarding the isolated energy systems, three countries with similar systems to the Spanish one have been selected: the French island of Corsica, the Italian Sardinia and Sicily and finally Crete in Greece. Even though these systems are not completely alike to the Spanish Islands, they are the only European comparable cases that could be analyzed.

4.2.1. British methodology for RES WACC

In January 2014, the UK government introduced a sliding feed-in tariff with Contracts for Difference (CfDs) as a way of supporting investment in low-carbon electricity generation. CfDs are contracts that provide long-term electricity price stability to developers and investors in low-carbon generation. Generators will receive the price they achieve in the electricity market plus a "top up" from the market price to an agreed level (the "strike price"). This "top up" will be paid for by consumers. Where the market price is above the agreed level, the generator would be required to pay back and thus ensure value for money and greater price stability for consumers. Agreements about the level at which the strike price is set takes into account the levelized cost of energy of each technology. (ECOFYS, 2014). The levelized cost of energy (LCOE) is the net present value of the unit-cost of electricity over the lifetime of a generating asset. It is often taken as a proxy for the average price that the generating asset must receive in a market to break even over its lifetime. It is a first-order economic assessment of the cost competitiveness of an electricity-generating system that incorporates all costs over its lifetime: initial investment, operations and maintenance, cost of fuel and cost of capital.

The methodology for calculating these costs is presented in **Equation 4.3**

$$LCoE = \frac{\sum_{t=1}^{n} \frac{I_t + OM_t + F_t}{(1+DR)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+DR)^t}} \qquad \mathbf{4.3})$$

$LCoE$ = Levelised cost of energy

I_t = Investment expenditures in the year t

OM_t = Operations and maintenance expenditures in the year t

F_t = Fuel expenditures in the year t

E_t = Electricity generation in the year t

DR = Discount rate, also known as hurdle rate

n = economic lifetime of the power plant

One of the most significant elements to get the LCOE is the discount rate. To come up with robust values for this parameter the Department of Energy and Climate Change (“DECC”) commissioned NERA Economic Consulting to make a report. This report[22] uses the Capital Asset Pricing Model (“CAPM”) framework as the foundation for the assessment of hurdle rates for each generation technology. However, the CAPM model has been supplemented, in recognition that certain of its limitations make it unsuitable as the sole model for assessing hurdle rates. In particular, the framework has been supplemented by including asymmetric risks and option values, both not captured within the standard CAPM context but likely to be reflected in project hurdle rates, thus providing a comprehensive foundation for assessment of financing costs for generation assets.

An important consideration for the assessment was the fact that the hurdle rate for any given generation project varies at different stages of the project life. In particular, projects at appraisal stage face development and construction risk, as well as allocation risk to the extent that they rely on government support (i.e. the need to secure CfDs contracts) – in contrast to operational assets whose

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[22] Electricity Generation Costs and Hurdle Rates Lot 1: Hurdle Rates update for Generation Technologies (2015)

residual cash flow risk is largely driven by market exposure (e.g. exposure to wholesale price risk, fuel price / Opex risk, etc.).

Nera considers that direct evidence on technology-specific hurdle rates for UK electricity generation projects is limited. There is a dearth of pure-play, technology-specific, generation-only listed companies. To inform hurdle rates estimates, they have therefore made use of a body of evidence as follows:

- Evidence from a bespoke survey of investors (24 responses) and a set of in-depth interviews (16 interviews). The survey and interviews were carried out in March to April 2015 and therefore reflect the views of investors at that time, before the general election in May 2015 and any Government announcements after April 2015.
- Direct market evidence of returns provided by yield companies for funds containing operational renewable assets, and analyst reports for UK energy companies whose businesses are focused on electricity generation.
- NERA bottom up WACC calculations for quoted UK electricity companies from stock market data.
- Calculations of the impact of certain risks on Interest Rate of Returns (IRRs) using simplified financial modelling tools (discounted cash flow modelling).

The report considered that more accurate hurdle rate estimates could be achieved by combining the survey data with direct market data on rates of return, or stock price data which can be used to derive betas. However, there are not many listed generation companies in the UK and the available market data does not give direct estimate of hurdle rates for new projects. Most listed companies cover generation, but also other activities, making their share prices and the implied betas or cost of capital of limited use for understanding the cost of capital for a new generation project. The WACC for a listed energy company is also not a direct measure of the technology-specific whole project hurdle rate. It reflects the returns required by debt and equity investors in that company for the risks that the whole company (not an individual project) is exposed to. A typical major UK electricity generation company will, for example, have a WACC that reflects:
a) The range of new generation technologies it invests in;
b) The set of generation assets it owns (which determine its revenues) – most of these assets are typically operational power stations that do not provide a reliable indication of the hurdle rate for a new generation asset at the appraisal stage;
c) Any non-generation assets it owns – including for example electricity networks which face relatively lower risks than generation assets and therefore have a lower WACC;
d) The geographies they are active in – often wider than just the UK.

A very small number of companies are focused on generation, but their share price relates to all company assets (mainly operational assets rather than new projects), and always of a portfolio of technologies.

As a result, the main source of the study are the surveys and the market data has been used to cross-check the survey results. The report uses market data from the British listed RES companies to get the WACC from each one of them. To choose the most liquid assets Nera performs a liquidity test. They tested stock liquidity using the bid-ask spread measure. Bid-ask spread is defined as the difference between daily lowest ask price and highest bid price as a percentage of the mid-price. One stock is deemed "illiquid" if the 1-year average of its daily bid-ask spread is over 1%. As mentioned before, the CAPM has been supplemented by including asymmetric risks and option values. The following table reflects this additional risks, based on investor interviews.

Table 24 Assessment of additional risks NERA (2015)

Scenario	Allocation & Development Risk	Novelty Premium	Construction Risk
High risk	200bps	25bps	Solar and Onshore 50 bps Biomass conversion: 100 bps Offshore: 150 bps
Medium risk	100bps	0	Same as above
Low risk	50bps	0	Same as above

Novelty Premium: due to the uncertainty about the future path of energy policy and the full implications of the Electricity Market Reform undertaken in the U.K (EMR), investors may derive value from deferring investment, i.e. adopting a "wait and see" approach, until they see the envisaged arrangements work in practice[23], and investors have confidence that no additional uncertainty/risk factors will affect their expected returns under the new framework.

Allocation risk: the risk arising due to the uncertainty of securing a commitment of support from government through the renewables support policy. This category includes both planning risk and the risk that support will not be secured.

Construction (Delay) Risk: the risk arising from the possibility of unexpected escalation in the construction costs of projects, or construction delays of a project.

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[23] At the time of writing Nera`s Report, projects supported by CfDs had not yet started generating, contract terms had not been tested through application to operating projects, and there had only been one allocation round – so it seemed likely that a novelty premium was still being applied by some investors, albeit at a level that is less than it was 1-2 years before.

Another interesting contribution of this report is the calculation of the cost of equity based on Yieldcos. Yieldcos are publicly traded closed-end renewable investment trusts. They own operating electricity generation assets, and therefore produce a (relatively) predictable revenue stream. These assets are not exposed to construction risk, allocation risk, or development risk, and generally attract investors that seek relatively stable incomes. The cost of equity of the yieldcos was estimated using the Dividend Growth Model (DGM). DGM is particularly suitable for estimating the cost of equity for yieldcos to the extent that 1) it is forward-looking, which is useful given that the yieldcos were only recently listed and thus have limited historical market data; and 2) DGM is most reliable when companies have stable, predictable dividend cash flows, a condition which is satisfied for the yieldco companies as they target dividend payments that rise with Retail Prices Index (RPI) as explicitly set out in their prospectuses and annual reports.

The DGM stipulates that the present value of a given stock's price should equal the sum of the discounted future dividend cash flows. Assuming perpetual dividend payments that grow at a constant rate g over time, the current stock price P_0 should equal:

$$P_0 = \frac{Div_0 * (1+g)}{r-g} \qquad \mathbf{4.4})$$

Where r is the required return on equity, and $D_1(Div_0 * (1+g))$ is the dividend payment of the next period. Alternatively, the formula can be used to obtain an estimate of r from D_0, P_0 and g:

$$r = \frac{Div_0 * (1+g)}{P_0} + g \qquad \mathbf{4.5})$$

Given that the yieldco dividends are intended to grow in line with the Retail Prices Index (RPI), the real cost of equity r equals the current yield of the yieldco.

4.2.2. DiaCore Report, February 2016

The DiaCore project aims at providing an estimation of the cost of capital for wind onshore projects across the EU and assessing the impact of policy design changes on cost of capital. The report "The impact of risks in renewable energy investments and the role of smart policies" will be studied in this section. The methodology used in the study consisted of two parts: identifying renewable energy investment risks and formulating policy measures to mitigate RES investments risks.

In Part 1, insights were gained in the cost of capital for investments in renewable energy sources (RES). In order to estimate the Weighted Average Cost of Capital (WACC), a theoretical model was constructed. In this model, an estimation of the cost of equity was made for onshore wind projects in each EU Member State based on the fluctuation of RES industries' share values compared to average fluctuations in share values. Secondly, the WACC was estimated for each Member State based on the modelled result of the cost of equity, information on the cost of debt as well as the debt, and equity ratio for onshore wind projects. As a reminder for the reader, the data presented in this study correspond to 2013 market data, hence the numerical values are not comparable with the current market data.

Cost of Debt

$$K_d = European\ R_f + CDS_{1OY} + PS \qquad \mathbf{4.6})$$

$\underline{European\ R_f}$: Average ten-year German bond, for the year 2013, which is equal to 1.57%

$\underline{CDS_{1OY}}$: Average annual ten-year Credit Default Swap (CDS) for each EU Member State

$\underline{PS(\ Project\ Spread)}$: Renewable Energy Project Spread: 3% onshore wind, 3.5% PV, 4% offshore wind. It is the risk component related to the risk of a RES project that is incorporated into the calculation of the total cost of debt. This indicator constitutes the risk premium charged on loans by bank borrowers and, based on Mazars (2012), exceeds 3% for wind energy technology.

Cost of Equity

$$K_e = R_f + \beta(MRP) \qquad \mathbf{4.7})$$

Following:

RF (Risk free rate): The study uses yields of the local long term bonds (10 years maturity) as an approximation where the country risk is included. Furthermore, the choice of the risk-free rate is consistent with the MRP used. (Spain 4.56%)

MRP (Market Risk Premium): For the purpose of this study the values obtained from surveys by Pablo Fernandez (2013) are used. First the MRP values of 2013 were used and for the countries that this was not available the values of 2012 were used. (Spain: 6.00%)

Beta: Renewable energy projects do not have any stocks listed, therefore they cannot estimate the Beta directly through a regression. However, a representative Beta is derived by using the returns of comparable listed companies, a method called peer review analysis. The steps followed to get this parameter are the following:

1. A representative sample of listed firms was collected. In total there are 52 companies listed in European stock markets and also in renewable energy indices. These indices are RENIXX World,

ALTEX Global, Ardour Global Alternative Energy IndexSM, DAXglobal Alternative Energy Index, Italian Renewable Energy Index, and ISE Global Wind Energy. (Full list of companies in Annex 1)

2. For every firm regression Betas were obtained using daily and monthly return observations for different time periods (5- 3- 1 year and 6 – 3 months for daily observations and 5-4-3-2 years for monthly observations). The values of Betas were statistically evaluated to test their explanatory value (R2) and statistical significance (t-statistic and p-value). The index used for market proxy was the MSCI ALL CAP[24].
3. All Betas that were statistically significant were averaged and unlevered using Hamada's equation. The debt to equity ratio used was the average ratio of the companies.
4. In total nine different Betas were obtained. Monthly returns were preferred over daily returns to avoid the illiquidity problem that would underestimate our Beta. From the monthly they chose five and four years results as they had the lowest standard error compared to three and two years
5. The two unlevered Betas were finally re-levered again to the target debt to equity ratio which is 70/30. For every country a different Beta is obtained as the corporate tax rate changes.
6. As a final step to cross-check the results the Beta is estimated using a sub-sample of the original. Companies that operate only into the wind and solar sector were included. The new Beta had no significant difference from the one obtained using the full sample.

After estimating the financing parameters, DiaCore gathered information on risks influencing the RES investments. (Figure 8) These risks influence the cost of equity and cost of debt for RES and, thus, the WACC of RES investments. The outcomes of the theoretical model were evaluated and tested during interviews with over 80 financial experts from 26 Member States. Based on these interviews, both the financial parameters and the ranking of the risks were adapted and used to draft country risk profiles for each EU Member State.

In the case of Spain, 4 interviews were conducted (3 consultants, 1 equity provider). The results of the CAPM/WACC model are compared with the interviews results in Table 25.

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[24] The MSCI World All Cap Index captures large, mid, small and micro-cap representation across 23 Developed Markets (DM) countries. With 11,605 constituents, the index is comprehensive, covering approximately 99% of the free float-adjusted market capitalization in each country.

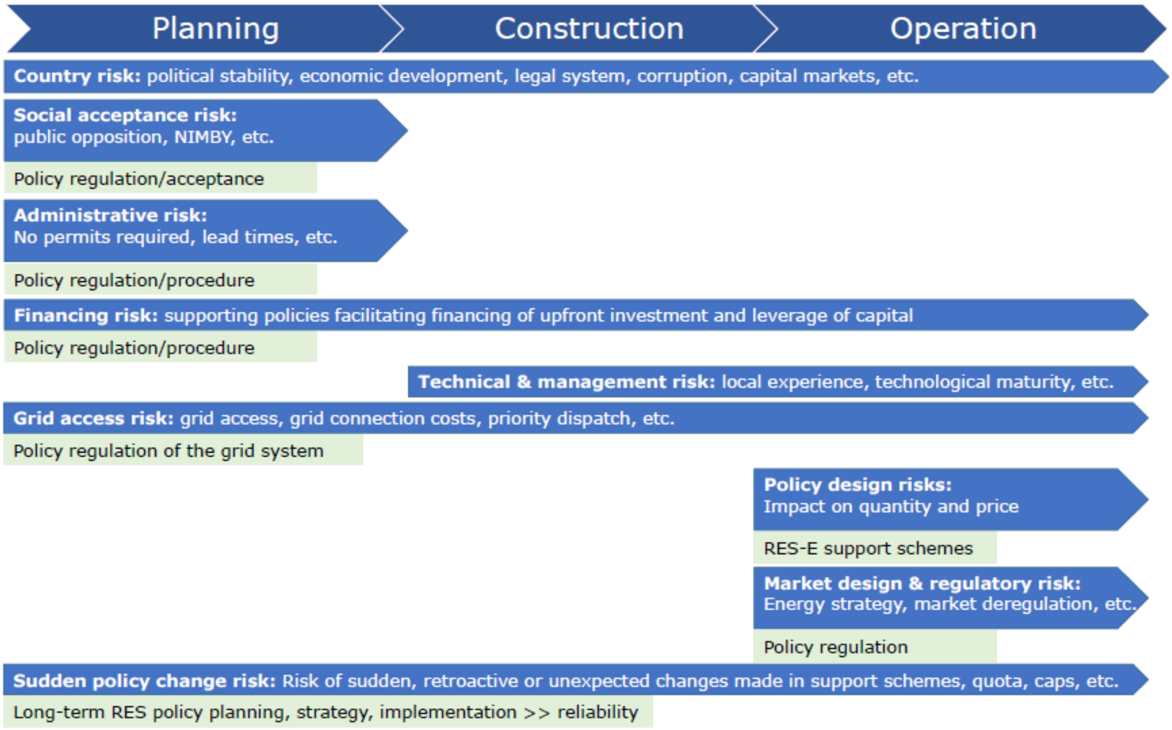

Figure 8. Risks affecting RES projects: Source: DiaCore

Table 25. WACC parameters for Spain according to Interviews. Source: DiaCore

Financial parameter	**Model value**	**Interviews**	**Comments**
Debt/Equity ratio	70/30	Agreement	70/30 constitutes a representative value.
WACC	8.1%	Divided 10%	Reasonable value. Average WACC of approximately 10% - higher for non-FIT supported projects was also mentioned.
Cost of equity	13%	Divided	13-15% Probably correct value. Higher for an onshore wind and even higher for offshore.
Cost of debt	7.9-8.7%	Divided	9-10%, One expert mentioned that it is fine, another stated an increase of about 20-30%, larger for offshore.
Debt term	10 years	No opinion	No feedback received on the debt term.

In Part 2, the focus of the DiaCore Report was to assess the impact of policy design changes on the cost of capital and to formulate policy measures to mitigate RES investments risks. No major development of this chapter will be presented in this review since the focus of this work is mainly to analyze the rate of return provided to RES generation. Even though it is important to mention that the report shows how the WACC changes when switching from one policy design (support mechanisms) to another.

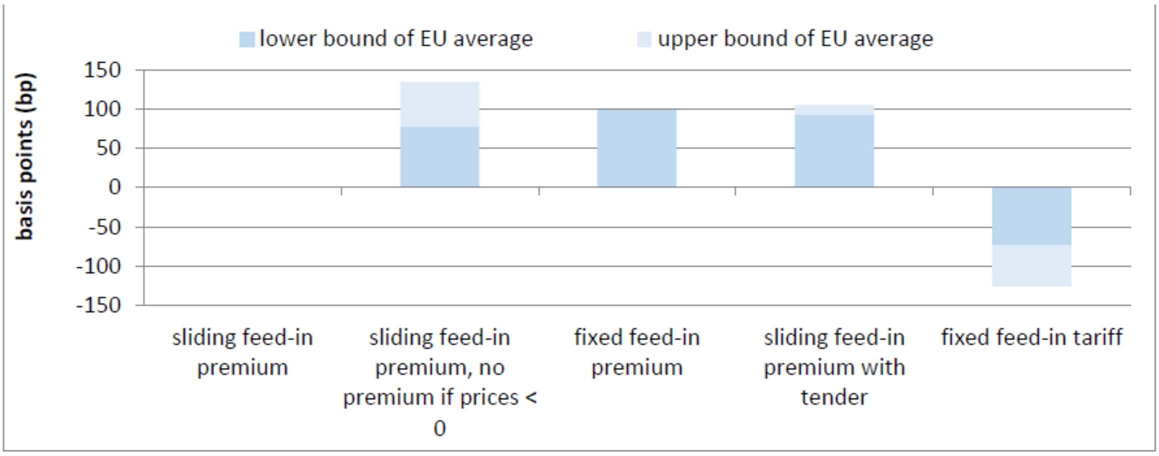

Figure 9. Changes of WACC under changing policy designs compared to Feed in Premium (FIP)

According to the report, countries where the fixed feed-in tariff mechanism is used have lower rate of returns than countries using other mechanisms such as fixed feed-in premiums or sliding feed-in premiums. This is because the exposure to the market creates additional uncertainty to the investors.

4.2.3. France: remuneration in the "Zones non interconnectées" (ZNI)

France accounts for several isolated power systems, from which Corsica resembles the most to the Spanish systems. This island is located west of the Italian Peninsula, southeast of the French mainland, and north of the Italian island of Sardinia.

Electricity production costs in such zones are very high. However, to ensure that all consumers, whether they are in mainland France or overseas territories, can benefit from the same electricity retail price, an equalization mechanism was implemented. The difference between production cost (and power purchase cost) and retail price is compensated (on a cost plus basis) to the local vertically integrated operator (EDF). The compensation is funded by a specific tax ('CSPE'), which is due by all electricity consumers. The CSPE (renewable and social surcharge on electricity bills) system is similar to the Spanish regulated payments that have been presented in previous sections. In 2016, renewable energies have been two thirds of the total CSPE. In particular solar and wind energy sectors, which represent 39% and 17% have been significant. CSPE is charged as a fixed part of the electricity bills and its amount is calculated every year based on costs forecasts and adjustments of previous years.

Regarding the isolated energy systems, they work with a methodology similar to the one presented in Section 3.2.2. The compensation includes a fixed portion, covering capital charges and fixed operating expenses, and a share proportional to the electricity generated, covering variable operating expenses. The fixed portion of the compensation comprises five components: remuneration of capital invested, amortization of capital, remuneration for working capital, fixed operating costs - differentiated between fixed costs of personnel and non-staff - and Expenses of Wholesale Maintenance Renewal (CRE, 2015).

As in the Spanish system, there is a rate of return. The pre-tax nominal rate of return on fixed capital for power generation facilities in the overseas departments and in Corsica is set at 11%, according to Order of 23 March 2006. No rate of return has been fixed for investments made in the Breton islands of Glénan, Ouessant, Molène and Sein and in the island of Chausey. For these islands, the rate of 7.25%, which was in place before the publication of the decree of 23 March 2006, continues to apply.

The Order of 27 March 2015 (Arrêté du 27 mars (2015)) has stablished some investments in the isolated systems (ZNI) for which the Commission of Energy Regulation (CRE), can modify the 11% rate of return in a range of (+/-) 500 basis points, after evaluating the risks of the projects, based on the studies presented by each project sponsor. These are:

- electricity storage facilities managed by the electricity system operator referred to in Article 4 of Decree No 2004-90 referred to above;

- demand management measures relating to the electricity consumption proposed by the electricity supplier referred in Article 4 of Decree No 2004-90.

No methodology for setting the 11% rate of return used in France has been found in this benchmarking. In addition to this, it is worth to state that the rate of return has been in place for more than 10 years, and no review mechanism has been found either.

4.2.4. Italy: Sardinia and Sicily

Italian electric market is subdivided in zones based on power transmission limitations between zones: there are 6 geographic zones and 4 national virtual zones. Therefore the market has at any given time ten different prices accounting for the congestion in the zones. Two of these zones can be considered as almost “isolated power systems” even though this is not completely true anymore because of the increasing connections built in the past years. As a result, the prices come from a market basis and there are not regulated costs like it happens in France or Spain. As it can be expected, prices in the islands are higher than the prices in mainland Italy.

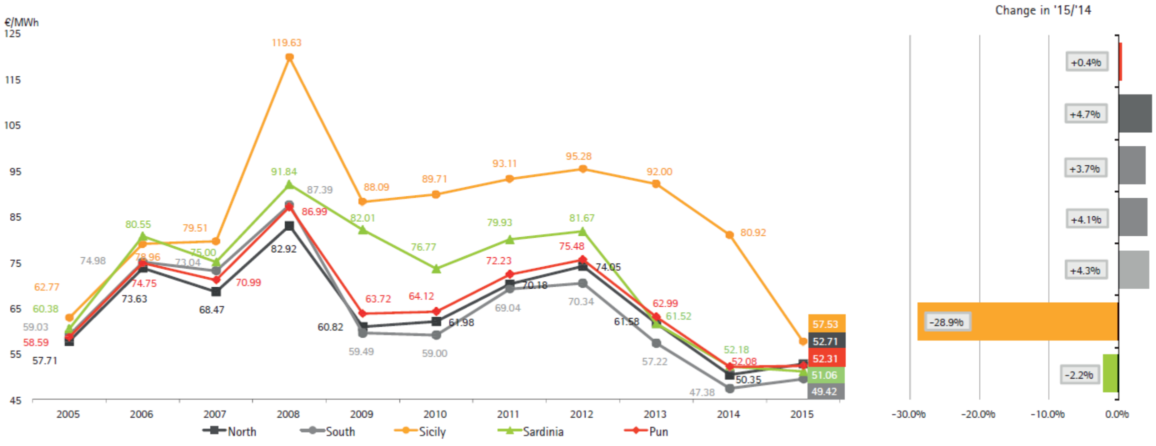

Figure 10 Yearly average zonal prices on the Italian Market

The government however has introduced some regulation for the so called “essential” plants, starting on January 1, 2015 and until the commissioning of the Sorgente-Rizziconi power line that connects Sicily with the mainland. Programmable Sicilian power plants that qualify as essential resources for the system’s reliability, are required to offer power on the Day Ahead Market at a stablished price based on the technology employed. Because of this regulatory measure the price has significantly decreased in the past years.

The higher generation costs in the islands are compensated by a National subsidy that ensures an earning and covers the balance loss due to the production of electrical energy at disadvantaged costs, allowing the consumers of the island to pay per kWh consumed the price of the unique national tariff in this way. Each year then, based on the balance presented by each company, a monetary compensation per kWh produced is given. In the decision 63/03 of the Italian Authority for Electrical Energy and Gas (AEEG),the integration tariffs for the distribution companies serving the minor islands are specified; it is stated for example that for the Island of Pantelleria the Italian government gives 0,1479 € per kWh sold.

As a conclusion, the Italian framework for isolated systems is different to the Spanish one. The rate of return is not explicitly used.

4.2.5. Greece: Crete

Crete is the largest Greek island and lies approximately 160 km south of the Greek mainland. Its peak demand is approximately 650MW and its energy consumption is about 3TWh. The energy demand on the island is covered mainly by three conventional power stations with a total installed capacity of 800MW and comprising steam turbines, open cycle gas turbines, one CCGT and several Diesel units. Additionally there are about 161MW of wind parks installed in the island, corresponding to 14% of the total energy supply, 1,5MW of PVs and 300kW of hydro-power. There are also hybrid power plants (HPS) -plants combining RES and storage units of about 360 MW and 273MW of solar thermal power plants, while 90 MW of PVs are already licensed.

There are several players in this market: one System Operator, several producers, producing electricity from different types of units (conventional units, RES, HPS etc.), retailers/suppliers.

Because of its yearly energy demand, Crete is a system offering proper conditions to set rules in order to boost new players to enter the market. A scheme of market organization in Crete is given in Figure 11

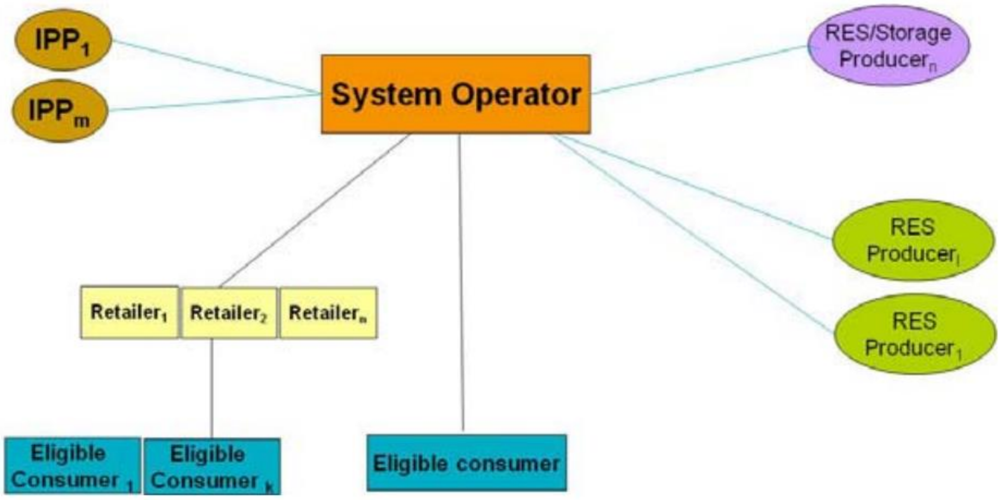

Figure 11. Crete Electric Market Structure

A single TSO is responsible for the technical and economic management of the system and among others:

- Manages the generation activity making sure that the electricity demand on the island is satisfied.
- Secures that there is no discrimination between generators operating in the island.
- Undertakes bilateral contracts with holders of generation and supply license and makes sure that the latter have access to the grid.

The TSO is responsible for forecasting the next day demand on an hourly basis as well as the amount of any auxiliary services necessary. Additionally the TSO is responsible for forecasting the energy to be produced from the Hybrid Power Stations (HPS). Conventional power units are required to provide an offer for a certain amount of energy to be produced. The price at which this energy will be remunerated is regulated and corresponds to the variable cost of the unit regarding its technical characteristics. The operation schedule is determined by the TSO in order to achieve minimum generation cost.

In these terms the system marginal price of the island is calculated. Priority in dispatch is always given to RES producers. Energy produced by the HPS's units is also prioritized in reference to the conventional power units, which supply the grid mainly at peak load hours in order to cover conventional capacity deficits.

As a conclusion, the Greek framework for Crete isolated system is different to the Spanish one. The rate of return is not explicitly used.

4.3. CNMC report on the airport sector

One of the key points of the proposed benchmarking relates to the analysis of the methodology used by the Airport's regulator – a division of CNMC – to calculate a rate of return of AENA (the Spanish airport´s operator)[25], to be considered in airport taxes calculation. The approximation of the allowed rate of return of AENA was performed through the estimation of WACC. However, due to sector and regulatory specificities, the approach used in the Airport`s sector has two major differences from other internal precedents within CNMC (The 2008 CNE Methodology for regulated gas and electricity networks, and the Methodology used in Telecoms – described in Fournier 2016) that should be highlighted. The first one is the way to measure the cost of the debt and the second one has to do with the risk free rate used in the CAPM model.

Cost of debt

As stated in STP/DTSP/180/16 report, Aena proposes to calculate the cost of the debt in accordance with its current estimated cost, having proposed a value of 1.42%. CNMC considered that, from a regulatory point of view, the best option for the calculation of the cost of debt would be to obtain the yield to maturity of Aena's recent debt issuances or those of comparable companies with the same credit rating. In addition to it, the interest rate swap (IRS) and corresponding credit default swap (CDS) could be used.

However, in practice these options were not available, since Aena and its peer companies, do not have a sufficient number of issuances nor they have quoted CDS.

Therefore, the alternative proposed by Aena was considered suitable for the estimation of the cost of debt, taking into consideration also that Aena's financing portfolio would be difficult to replicate by other comparable companies, since it maintains significant amounts of financing with public entities such as the Instituto de Crédito Official (ICO) and the European Investment Bank (EIB).

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[25] STP/DTSP/180/16. Acuerdo por el que se emite el informe previsto en el artículo 25.3 de la Ley 18/2014, de 15 de octubre, de aprobación de medidas urgentes para el crecimiento, la competitividad y la eficiencia en relación al documento de regulación aeroportuaria.

Risk free rate

As stated in STP/DTSP/180/16 report, Aena proposed to calculate the risk-free rate as the average of the last 5 years of the yield to maturity of the 10 Years Spanish Bond. However, according to the report, in liquid financial markets, the best representation of the cost of financing in the next five years (length of the regulatory period) is the current market price.

To avoid using a spot value, mean values should be used. The use of means of greater or lesser period (3 months, 6 months or 1 year) will depend on market volatility and aims to obtain a value that represents as best as possible the current cost of financing. A reasonable period to avoid cyclical distortions in the markets, which in turn reflects an adequate approximation of the current economic context would be 6 months. This period is also used to calculate the yield to maturity of bonds in other sectors such as telecommunications, when estimating the WACC.

However, if we were to estimate prospectively the risk-free rate that would apply during the next five years period, an alternative could be to take the current implicit price of the 10 Years Spanish Bond at different times. The implicit price corresponds to the expected value that the 10 Years Spanish Bond will have in a future time (1, 2, 5 years). It is called implicit since it is not observed directly, and it is necessary to use the values of other longer-term bonds to calculate it. For example, the yield to maturity of the 15-year Spanish Bond is used together with the yield to maturity of the 10-year Spanish bond, to obtain the implicit value that the 10-year Spanish bond would have in 5 years.

This alternative has the advantage that, as in the case of the current 10-year bond, it is a value that can be obtained from market values. However, as a general rule, the use of implicit interest rates can overestimate the cost, since it may include a premium for uncertainty, as it occurs with the interest rate curve at different times, which usually has a slope growing.

Based on the above, the CNMC considered in the STP/DTSP/180/16 report that although methodologically the best alternative in setting the risk free rate would be the current yield to maturity of the 10-year Spanish Bond, the series of Spanish bond yield was at historical low values. Therefore, taking into account the above, as well as the uncertainty that may exist on the Spanish bond yield for the next five-year period, and also, in order to give predictability and certainty to the estimate, it was considered appropriate to use a mean between the current spot value and the implicit value in 5 years' time, i.e. the average at the beginning and at end of the five-year period.

Chapter 5

5.Proposed Methodology

After a complete review of previous reports and possible benchmarking cases, this chapter presents the methodology object of this work. It is important to recall that the aim of this thesis is to propose a methodology to approximate the spread on the 10-year Spanish government bond, throughout the approximation of the WACC of Renewable energy generation and generation in isolated energy systems– starting in 2020. Therefore, two concerns must be considered:

1) This research aims to propose a methodology that will be replicated in 2018; so, numerical results derived from this study will not be conclusive since they have been obtained based on current data – up to March 2017. Hence, data will have to be updated next year and only then, conclusive numerical results could be offered to be applied for the next regulatory period.

2) Taking into account the concern previously described, the allowed rate of return – based on the average yield of the 10-year Spanish bond in the last 24 months – would be 1.58%[26] plus a spread. This spread would be calculated as the difference between the average yield of the bonds (1.58%) and the allowed rate of return based on WACC of each activity (see Table 26).

Table 26. Estimation of the spread to be added to the allowed rate of return

Estimation of the spread	
Allowed rate of return based on WACC	WACC/(1-Tax)
Average yield of 10-year Spanish Bond	1.58%
Proposed Spread	[WACC/(1-Tax)] - 1.58%

5.1. Allowed rate of return for renewable generation

In Fournier (2016), a framework was developed for estimating the rate of return for transmission and distribution activities. In this analysis, we maintain that framework, described in Chapter 4, but we extend its implementation to renewable generation, taking into account its specificities. In addition to this, the framework has been further adapted in order to cover all key specific risks that affect the technologies covered under the concern of this work. As explained before, the allowed rate of return for a project is determined by the expected return on equity and debt that investors require for contributing each respective type of capital, given the risks faced by the project.

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[26] Value obtained from daily observations taken from 30/March/2015 to 30/March/2017

The WACC (and implicitly the CAPM) is the traditional model for estimating the cost of capital used by investors, financial analysts and regulators alike, due to its simplicity, accessibility and robustness. Moreover, standard corporate finance textbooks and survey evidence suggests that the model remains the leading framework used by practitioners even outside the regulated sectors. It is against this background that we use a framework based on the WACC/CAPM. Nonetheless, this framework is supplemented to account for asymmetric risk. By supplementing the CAPM framework to capture other risk categories particularly relevant to renewables investments, we account for the fact that the marginal investor in a renewable energy project might be facing asymmetric risk.

The asymmetric risk is the type of risk that entails a potential significant negative effect to investors that is not compensated by an equally potential positive effect. This type of asymmetric risk might not be captured by the CAPM model.

In addition to this, the proposed methodology has been adapted to account for electricity price risk that investors in renewable projects face to some extent, as explained in section 3.2.1.

Therefore the model used will be:

$$WACC_{AT} = \left(\left[\frac{Debt}{\text{Debt+Equity}}\right] * R_{debt} * (1-T) + \left[\frac{Equity}{\text{Debt+Equity}}\right] * R_{equity}\right) + S_{RES} \qquad \textbf{5.1)}$$

S_{RES}: It is the spread for additional risks that are not considered in the traditional WACC/CAPM.

The following sections will provide all the elements to get the allowed rate of return for renewable generation projects. Section 5.1.1 will show the methodology elements. Then section 5.1.2 covers the cost of equity, and section 5.1.2. presents the approach used to get the cost of debt. Finally, in section 5.1.4. additional risks added to the WACC will be presented.

5.1.1. Methodology elements

There are some methodological elements that have to be chosen when using the CAPM, such as the peer group of companies or the sources of information. These elements are not directly related to the calculations but are the guidelines that allow this methodology to be replicated and assessed.

5.1.1.1. Peer group of companies

Renewable energy projects in Spain do not have any stocks listed, therefore we cannot estimate the Beta directly through a regression. However, a representative Beta is derived by using the returns of comparable listed companies, a method called peer review analysis. Some criteria must be taken into account for selecting the companies:

- Renewable energy generation: Only companies which have as a core activity the generation of electricity with renewable energy sources, or that have a significant percentage or their revenues come from RES generation, should be included. Companies manufacturing the infrastructure and technical components are part of the RES sector but are not considered as peers, unless they own and operate the projects they develop, and the incomes from RES generation account for a significant amount of their revenues.

- Geographical region: Spanish economy shares many regulatory similarities with Western European countries; hence, only this region will be considered in the selection of peer utilities. In addition, the typical investor considered in this work takes Europe as his relevant investment geographical region.

- Economic situation: Utilities belonging to countries with an economic situation that differs from the Spanish's should not be taken into account. The proposed measurement from this criterion is through countries' ratings. Then, countries with worse ratings than "BB- / Ba3" – depending on the scale – should be excluded from the peer group.

- Available market data: As previously explained, market data are usually obtained from stock exchanges sources (e.g. Bloomberg). However, data availability might also constraint the methodology. Therefore, companies with insignificant market data should be excluded from the peer group.

The first approach used to get the companies meeting the mentioned criteria was to use the Equity Screening function in Bloomberg. This function was used as follows:

EQS: Equity Screening function

- ➢ Sectors ➜ Utilities ➜ Electricity
- ➢ *Product Segments*: Utilities ➜ Power Generation ➜ Renewable Energy Generation

> *Latest FY Product Segment Revenue Percent:* Greater than or equal to 0.1
> *Country of domicile*: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom.

Next step consisted in the evaluation of each company in order to determine their fulfilment with the abovementioned criteria, utilities complying with the totality of such criteria remained in the Final peer group; on the contrary, any utility failing any criterion was removed from the list. Table 27 shows the list of utilities that were excluded from the final list of peer group and the reason of such exclusion.

Table 27. Companies not included in the final group

Ticker	Name	Country	Reason of Exclusion
GES DC Equity	GREENTECH ENERGY	DENMARK	No relevant market data
FRS SM Equity	FERSA ENERGIAS REN	SPAIN	No relevant market data
RUR LN Equity	RURELEC PLC	BRITAIN	No relevant market data
ENINV BB Equity	4ENERGY INVEST SA	BELGIUM	No relevant market data
SYW GR Equity	SONNE + WIND BETEI	GERMANY	No relevant market data
VLTSA FP Equity	VOLTALIA-REGR	FRANCE	No relevant market data, Worldwide operations
ALVEL FP Equity	VELCAN	FRANCE	No operations in Europe
AFK NO Equity	ARENDALS FOSSEKOM	NORWAY	No relevant market data
HNA NO Equity	HAFSLUND-A SHS	NORWAY	No RES generator
LEC GR Equity	LECHWERKE AG	GERMANY	No relevant market data
MNV6 GR Equity	MAINOVA AG	GERMANY	No relevant market data
UN01 GR Equity	UNIPER SE	GERMANY	No relevant market data
FTL IM Equity	FINTEL ENERGIA GRO	ITALY	No relevant market data
ENGI FP Equity	ENGIE	FRANCE	Worldwide operations
IRE IM Equity	IREN SPA	ITALY	No RES generator
FHW GR Equity	FERNHEIZWERK NEUK	GERMANY	No relevant market data, No RES generator
RWE GR Equity	RWE AG	GERMANY	No RES generator
EVN AV Equity	EVN AG	AUSTRIA	No RES generator
GES DC Equity	GREENTECH ENERGY	DENMARK	No relevant market data

The next step was to check some indices that are representative of the RES sector in Europe. Diacore (2015) report presents five indices that were screened in this study to look for additional companies that could have been excluded from the Bloomberg Equity Screen. These indices are RENIXX World, ALTEX Global, Ardour Global Alternative Energy IndexSM, DAXglobal Alternative Energy Index, Italian Renewable Energy Index, and ISE Global Wind Energy. After checking those indices, seven companies were added to the final list of peer companies:

Table 28. Companies found on Indices

Ticker	Name	Country	Index
AGA IM Equity	AGATOS SPA	ITALY	Italian Renewable Energy Index
ECA IM Equity	ERGYCAPITAL SPA	ITALY	Italian Renewable Energy Index
FDE IM Equity	FRENDY ENERGY SPA	ITALY	Italian Renewable Energy Index
GGP IM Equity	GRUPPO GREEN POWER SPA	ITALY	Italian Renewable Energy Index
ANA SM Equity	ACCIONA SA	SPAIN	ISE Global Wind
SLR SM Equity	SOLARIA ENERGIA Y MEDIO AMBI	SPAIN	Ardour
ELAB IM Equity	ENERGY LAB SPA	ITALY	Italian Renewable Energy Index

Afterwards, the peer group of utilities used in DiaCore (2016) report was analyzed and three companies (See Table 29) were added to the final peer group. In Annex 1 the complete list of companies used in that report is presented, with the reasons of exclusion of the companies from the peer group.

Table 29. Companies added from Diacore (2016)

Ticker	Name	Country
Cap Gy Equity	Capital Stage Ag	Germany
Hrpk Gy Equity	7c Solarparken Ag	Germany
Eolub Ss Equity	Eolus Vind Ab-B Shs	Sweden

A final group of securities was added to the peer companies, this is the Yieldcos group. These Yieldcos are publicly traded closed-end renewable investment trusts. They own operating electricity generation assets, and therefore produce a (relatively) predictable revenue stream. These assets largely consist of solar and wind farms that have entered into long-term energy delivery contracts or similar. Yieldcos are not exposed to construction risk, or development risk, and generally attract investors that seek relatively stable incomes. There are eight funds quoted as Yieldcos (See Table 30) in Europe, all belonging to the Indxx Global YieldCo Index- Most of these funds invest in wind and solar generation projects while John Laing Environmental Assets also has exposure to waste management.

Table 30. Yieldcos in Europe

Ticker	**Name**	**Country**
UKW LN Equity	GREENCOAT UK WIND PLC	BRITAIN
JLEN LN Equity	JOHN LAING ENVIRONMENTAL ASS	BRITAIN
BSIF LN Equity	BLUEFIELD SOLAR INCOME FUND	BRITAIN
TRIG LN Equity	RENEWABLES INFRASTRUCTURE GR	BRITAIN
NESF LN Equity	NEXTENERGY SOLAR FUND LTD	BRITAIN
ABY Us Equity	ATLANTICA YIELD PLC	SPAIN
SAY SQ Equity	SAETA YIELD SA	SPAIN

After this process, the final list of peer companies leaded to 51 utilities. Then, with the companies selected from this analysis, two groups of companies have been created. The first one is formed by 26 companies that could be considered as pure players in the renewable generation business. The list is shown in Table 31.

Table 31 Pure RES companies

	Ticker	Name	Country
1	Drx Ln Equity	Drax Group Plc	Britain
2	Good Ln Equity	Good Energy Group Plc	Britain
3	Ukw Ln Equity	Greencoat Uk Wind Plc	Britain
4	Trig Ln Equity	Renewables Infrastructure Gr	Britain
5	Nesf Ln Equity	Nextenergy Solar Fund Ltd	Britain
6	Bsif Ln Equity	Bluefield Solar Income Fund	Britain
7	GES DC Equity	Greentech Energy Systems	Denmark
8	Abio Fp Equity	Albioma SA	France
9	Ftrn Fp Equity	Futuren SA	France
10	Cap Gy Equity	Capital Stage Ag	Germany
11	Ekt Gr Equity	Energiekontor Ag	Germany
12	Hrpk Gy Equity	7c Solarparken Ag	Germany
13	Aga Im Equity	Aga Im Equity	Italy
14	Arn Im Equity	Alerion Cleanpower	Italy
15	Eca Im Equity	Ergycapital Spa	Italy
16	FKR IM Equity	Falck Renewables Spa	Italy
17	FDE IM Equity	Frendy Energy Spa	Italy
18	GGP IM Equity	Gruppo Green Power Spa	Italy
19	TER IM Equity	Ternienergia Spa	Italy
20	IB IM Equity	Iniziative Bresciane-Inbre S	Italy
21	KRE IM Equity	K.R. Energy Spa	Italy
22	EDPR PL Equity	Edp Renovaveis SA	Spain
23	ABY Us Equity	Atlantica Yield Plc	Spain
24	SAY SQ Equity	Saeta Yield Sa	Spain
25	FRS SM Equity	Fersa Energias Renovables SA	Spain
26	Eolub Ss Equity	Eolus Vind Ab-B Shs	Sweden

The second group comprises all 51 utilities in the final list of peer companies. The list is shown in Table 32.

Table 32. Group of peer companies

	Ticker	Name	Country
1	Ver Av Equity	Verbund Ag	Austria
2	Drx Ln Equity	Drax Group Plc	Britain
3	Good Ln Equity	Good Energy Group Plc	Britain
4	Sse Ln Equity	Sse Plc	Britain
5	Ukw Ln Equity	Greencoat Uk Wind Plc	Britain
6	Jlen Ln Equity	John Laing Environmental Ass	Britain
7	Trig Ln Equity	Renewables Infrastructure Gr	Britain
8	Nesf Ln Equity	Nextenergy Solar Fund Ltd	Britain
9	Bsif Ln Equity	Bluefield Solar Income Fund	Britain
10	Denerg Dc Equity	Dong Energy A/S	Denmark
11	GES DC Equity	Greentech Energy Systems	Denmark
12	Fortum Fh Equity	Fortum Oyj	Finland
13	Abio Fp Equity	Albioma SA	France
14	Diren Fp Equity	Direct Energie	France
15	Edf Fp Equity	EDF	France
16	Ftrn Fp Equity	Futuren SA	France
17	Cap Gy Equity	Capital Stage Ag	Germany
18	Ekt Gr Equity	Energiekontor Ag	Germany
19	Mvv1 Gr Equity	Mvv Energie Ag	Germany
20	Pne3 Gr Equity	Pne Wind Ag-Reg	Germany
21	Eoan Gr Equity	E.On Se	Germany
22	Hrpk Gy Equity	7c Solarparken Ag	Germany
23	IGY GR Equity	Innogy Se	Germany
24	EBK GR Equity	Enbw Energie Baden-Wuerttem	Germany
25	A2a Im Equity	A2a Spa	Italy
26	Aga Im Equity	Aga Im Equity	Italy
27	Ace Im Equity	Acea Spa	Italy
28	Arn Im Equity	Alerion Cleanpower	Italy
29	Eca Im Equity	Ergycapital Spa	Italy
30	ENEL IM Equity	Enel Spa	Italy
31	ERG IM Equity	Erg Spa	Italy
32	FKR IM Equity	Falck Renewables Spa	Italy
33	FDE IM Equity	Frendy Energy Spa	Italy
34	GGP IM Equity	Gruppo Green Power Spa	Italy
35	TER IM Equity	Ternienergia Spa	Italy
36	IB IM Equity	Iniziative Bresciane-Inbre S	Italy
37	ELAB IM Equity	Energy Lab Spa	Italy
38	KRE IM Equity	K.R. Energy Spa	Italy
39	GALA IM Equity	Gala Spa	Italy
40	EDP PL Equity	Edp-Energias De Portugal Sa	Portugal
41	EDPR PL Equity	Edp Renovaveis SA	Spain
42	GAS SM Equity	Gas Natural Sdg SA	Spain
43	ELE SM Equity	Endesa SA	Spain
44	IBE SM Equity	Iberdrola SA	Spain
45	ANA SM Equity	Acciona SA	Spain
46	ABY Us Equity	Atlantica Yield Plc	Spain
47	SAY SQ Equity	Saeta Yield Sa	Spain
48	SLR SM Equity	Solaria Energia y Medio Ambie	Spain
49	FRS SM Equity	Fersa Energias Renovables SA	Spain
50	ARISE SS Equity	Arise AB	Sweden
51	Eolub Ss Equity	Eolus Vind Ab-B Shs	Sweden

5.1.1.2. Period of Study

As presented in section 4.1 the period of study refers to the starting time from which historical data is going to be taken from. If the allowed rate of return could be modified on an annual basis, taking historical data would not be a suitable option. In that case the correct calculation would be to use spot data from the market, under the argument that the best prediction for tomorrow's market price is simply today's price. Although, since the allowed rate of return will be fixed for a period of six years, in section 4.1, it was showed that the most appropriate periods of study are **three and six years** of historical data**.**

5.1.1.3. Frequency of Observations

The frequency of observations used is the suggested in Fournier (2016). The data collected is statistically significant and enough to carry out the analysis. The preferred use of daily data could underestimate the risk of assets that do not trade on a continuous basis (Damodaran, 2015) , although this problem is solved with the use of the liquidity check performed in section 5.1.2.4.

Table 33. Frequency of Obervations

Parameters	Relevant frequency
Gearing ratio	Quarterly
Sovereign Bonds	Daily
IRS	Daily
Betas	Daily
CDS	Daily
Utilities Bonds	Issue date
Debt records (Book values)	Yearly

5.1.1.4. Investor´s Horizon

The investor´s horizon proposed for this methodology is medium-long term. Hence, market instruments with a maturity around 8-12 years will be preferred over the rest; specifically, instruments with a horizon of 10-years will be primarily sought.

The reasons that justify this decision are explained as following: 1) 10-year horizon is related with the expected horizon of medium-long term investors (e.g. investors of electricity generation); 2) the use of this horizon is a common practice among European regulators; 3) market liquidity of instruments with this horizon is appropriate enough in order to reflect the right market value of the financial instruments; and 4) this horizon is in line with the methodology to estimate the allowed rate of return used in previous CNMC reports (Gandolfi, 2009). Table 5.13 shows the relevant horizon for some market instruments – according to investor’s horizon – that will be later introduced.

Table 34. Relevant Investor Horizon

Instrument	Relevant horizon
CDS - Credit Default Swaps	10 years
Utilities' Bonds	8-12 years
Sovereign Bonds	10 years
ISR - Interest Swap Rate	10 years

5.1.1.5. Source of information

All the information used in this work comes from publicly traded companies and is available to any interested party. For the financial data the preferred source will be the Bloomberg platform.

5.1.2. Cost of Equity (CAPM)

The proposed methodology is based on the CAPM model like almost all European regulators do; moreover, this approach is also in line with the jurisprudence used by CNMC in other sectors. The Capital Asset Pricing Model (CAPM), states that the expected return on an asset is a function of the degree of systematic risk inherent in the cash flows of that asset, as follows:

$$E(R_E) = E(R_f) + \beta_e \left(E(R_m) - E(R_f)\right) \tag*{5.2)}$$

Where,

$E(R_E)$ is the expected return on equity;

$E(R_f)$ is the expected return on a risk-free asset;

$E(R_m)$ is the expected rate of return for the market (and thus $E(R_m) - E(R_f)$ is the expected risk premium);

β_e is a measure of the systematic risk of the equity, the "equity beta".

The CAPM is the traditional model for estimating the cost of capital, used by investors, financial analysts and regulators alike, due to its simplicity, accessibility and robustness. Moreover, standard corporate finance textbooks and survey evidence suggest that the model remains the leading framework used by practitioners even outside the regulated sectors.

5.1.2.1. Optimal gearing ratio

There are several ways to get the optimal gearing ratio for a company; one approach could be the assumption that companies optimize their level of debt since they are first interested to do so. Another way is to set a ratio based on the objectives pursued by the regulatory authorities. The first approach will be followed in this work because of the lack of regulatory precedents. Two methodologies were used to do so.

The first method is the usual one and is the average of the gearing ratio of every peer company. Net Debt is computed as the difference of Total Debt minus Cash and Cash equivalents. The gearing ratio refers to the proportion of the Net Debt over the Net Debt plus Market capitalization (see **Equation 5.2**).

$$\frac{\sum_{\forall\, ut} \dfrac{Net\ debt_{ut}}{Net\ debt_{ut} + Market\ cap_{ut}}}{\#\, utilities} \qquad \mathbf{5.2})$$

It is important to highlight that this formulation implies the same weight to all the peers; however, an alternative method was also explored. **Equation 5.3** recognizes the different weights of all the utilities; therefore, data of small utilities does not have a significant impact on the overall result.

$$\frac{\sum_{\forall\, ut} \quad Net\ debt_{ut}}{\sum_{\forall\, ut} \quad Net\ debt_{ut} + Market\ cap_{ut}} \qquad \mathbf{5.3})$$

Results from aforementioned developments are shown in Table 35. It can be observed that differences between Equation 1 and Equation 2 are significant in the case of pure RES companies. This suggests that the size differences in pure companies are important. Even though, since one of the principles of the Spanish regulatory framework is to use the same rate of return regardless the size of the companies, the results from equation 5.2 will be taken as the reference. Thus, the optimal gearing ratio of peer utilities ranges between 51% and 60%, being the 6-year period the one with the highest ratios.

Table 35. Observed gearing ratios

	Equation 5.2		**Equation 5.3**	
	All	Pure	All	Pure
1 year	51%	58%	50.5%	48.8%
3 years	52%	59%	50.6%	49.7%
6 years	53%	60%	51.6%	52.9%

The DiaCore (2016) report suggests a 70% gearing ratio for Spain and the report on the British hurdle rates (NERA, 2015) uses values ranging from 70% to 80%, although the market values suggest much lower values of gearing that reflect the current market conditions. The value used in this work will be 60%, which is the upper limit of the market values and it is closer to other gearing ratios used in the mentioned reports.

5.1.2.2. Tax rate

As mentioned in section 5.2.2 the preferred tax rate is the statutory tax rate rather than the effective tax rate. The source of information for these rates is the OECD (2017)

Table 36. Corporate income tax rates of relevant European countries – OECD 2017

Country	Corporate Tax Rate
Austria	25,0%
Belgium	33,0%
Denmark	22,0%
Finland	20,0%
France	34,4%
Germany	15,8%
Italy	24,0%
Netherlands	25,0%
Norway	24,0%
Portugal	28,0%
Spain	25,0%
Sweden	22,0%
United Kingdom	19,0%

5.1.2.3. Risk free rate (RFR)

Two possible approaches to this parameter have been assessed in this work. The first one is the use of historical data and it was proposed in Fournier (2016) based on the traditional way it is estimated among other regulators. The second approach comes from the CNMC document about the rate of return for AENA (See section 4.3) and it is based on a forward looking perspective.

Historical Values

The first methodology takes the simple average yield of the 10-year Spanish government bond based on daily observations as the best alternative to approximate the Risk free rate of investors. This approach (Approach 1) already takes into consideration the Country Risk Premium of Spain.

Figure 12. Yield (Spot yield to maturity) of the 10 years Spanish Bond 2011-1017

Depending on the selected period of study, the values of RFR Approach 1 vary within a range of 1.37% and 3.46% (see Table 9).

Table 37. Average Yield Spanish Bond

Period	Average Yield
1 Year	1.37%
3 Years	1.79%
6 Years	3.46%

Forward-looking Values

As mentioned in section 4.3, an alternative way to estimate the RFR is to take the best possible proxy of the future value of the state bonds for the relevant period of study (in this case 6 years because that is the length of each regulatory period). The methodology proposed in the airport sector report is to calculate the mean between the spot value of the 10 years Spanish bond before the beginning of the regulatory period, and the current implicit price of the 10 years Spanish Bond at the end of the regulatory period. The implicit price corresponds to the expected value that the 10 years Spanish Bond will have in 6 years (at the end of the regulatory period). It is called implicit since it is not calculated directly, as it is necessary to use the values of other longer-term bonds. For example the 16-year bond and the 6-year bond are necessary to obtain the implicit value that the 10-year bond would have in 6 years. The implicit value is calculated adapting the formula of forward rates as follows:

$$(1+s_{p+10})^{p+10} = (1+s_p)^p * (1+f_{(p,p+10)})^{10} \qquad \textbf{5.4)}$$

Where,

p: length of regulatory period (6 years)
10: is the investor`s horizon that has been chosen (10 years)
s_{p+10}: Spot rate (Yield to maturity) of the Spanish bond with a maturity of p+10 years
s_p: Spot rate of the Spanish bond with a maturity of p years
$f_{(p,p+10)}$: is the forward rate or implicit price that that the 10 years bond will have in p years' time (at the end of the regulatory period).

Equation 5.4 reflects the two alternatives that any investor could have at the beginning of the regulatory period that should be financially equivalent at that moment:

Alternative A) Buy a zero coupon Spanish Bond with 16 years maturity or;
Alternative B) Buy a zero coupon Spanish Bond with 6 years maturity and after 6 years, reinvest the money in a zero coupon Spanish Bond with 10 years maturity.

The forward rate is obtained according to **Equation 5.5**. It corresponds to the expected price that the 10 year Spanish Bond will have in 6 years.

$$f_{(p,p+10)} = \left(\frac{(1+s_{p+10})^{p+10}}{(1+s_p)^p}\right)^{\frac{1}{10}} - 1 \qquad \textbf{5.5)}$$

For the spot rates, following CNMC precedents, the mean of a 3 months period has been used. The resulting risk free rate obtained under this approach is 2.38%.

Results

Finally, the proposed approach is the one based on historical values because it would provide the agents with a “correction” mechanism of the rate of return at the end of each regulatory period. With the historical value of the risk free rate, the investors will know that any change of the current conditions will be acknowledged in the next regulatory period. The latter reduces uncertainty for investors given the fact that the current regulatory framework stablishes a unique rate for the whole of the regulatory period, with no possible review. The forward looking approach is theoretically supposed to be the best forecast of the future market conditions, but it is still based on expectations of the market and does not guarantee that the forecasts will actually happen.

5.1.2.4. Beta coefficient

Regression analysis is used to determine the beta coefficients. Some methodological aspects must be taken into account during this step. No standard procedure is set as reference since each of them has advantages and disadvantages.

Reference market: Theoretically, the CAPM states that the reference market should include all the investment possibilities where investors might place their capital; however, in reality, no index includes all these alternatives. Therefore, the most common practice to estimate the beta of a company is to use the most relevant index for the domestic investors of that company. Additional considerations are related to:

> i) Selection of a global, European or national index. With this in mind, (Gandolfi, 2009) introduces the concept of 'home bias', which alleges that "investors tend to invest in securities from their same country due to their market knowledge and the existence of transactions costs".
>
> ii) Selection of a general index or selective index. The latter one might be preferable since it may consider only liquid securities; nevertheless, the sample might be biased due to the subjective criteria employed.

Following the precedents, local indices were used for the beta coefficients (for each company, its relevant domestic index). In Bloomberg the parameter is extracted using the text "RAW BETA" and overriding the period of study to the needed period. The betas for each company that are obtained from Bloomberg cannot be directly compared among themselves since they are affected by their own level of leverage.

As a consequence, the betas of all the utilities must be homogenized by removing the leverage effect by applying the Modigliani –Miller theorem[27] (see **Equation 5.6**):

$$\beta_U = \frac{\beta_L}{\left[1 + \frac{D}{E} * (1 - T)\right]} \qquad \mathbf{5.6})$$

Where:

- β_U – Utility's beta without leverage (Unlevered).
- β_L – Utility's beta with leverage (obtained in step 2).
- D/E – Utility's leverage ratio.
- T – Corporate tax rate applicable for each company.

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[27] http://www.iese.edu/research/pdfs/DI-0488-E.pdf

Debt (D) is taken from book values and the equity (E) is obtained from market values. Additionally, corporate tax rate (T) is obtained from the tax rate applicable in each of their countries at that time. The unlevered beta of renewable energy generation can be approximated throughout the average of the unleveraged betas of all the peer companies.

Computation of the re-levered beta β_{RL}.

It is important to highlight that only levered – or re-levered – betas can be used in order to compute the WACC. Thus, levering the beta of renewable energy generation is required. **Equation 5.7** is typically used to help in this process by applying both, an optimal leverage ratio and an expected tax rate (these terms will be explained in subsequent sections).

$$\beta_{RL} = \beta_U * \left[1 + \left(\frac{D}{E}\right)^{opt} * (1 - T^{exp})\right] \qquad \textbf{5.7)}$$

Where:

- β_{RL} – Re-levered beta
- β_U – Unlevered beta
- $\left(\frac{D}{E}\right)^{opt}$ – Optimal leverage ratio.
- T^{exp} – Expected tax rate.

Liquidity Check

One commonly-discussed violation of the CAPM assumption is the thin-trading effects, i.e. the notion that price signals of illiquid stocks (i.e. stocks traded more thinly than the market index) are not assimilated simultaneously, which leads to downward bias in the beta estimates. Nera (2015) report uses a liquidity check which will be performed in this work as well.

Liquidity of the stocks was tested using the bid-ask spread measure. Bid-ask spread is defined as the difference between daily lowest ask price and highest bid price as a percentage of the mid-price. A stock is deemed “illiquid” if the 1-year average of its daily bid-ask spread is over 1%. (NERA, 2015) As shown in Table 38, most energy utilities are liquid. However among the renewable generation companies (pure RES) some are not liquid, which to some extent indicates market inefficiency for small stocks. For the beta calculation we have therefore included only the liquid stocks.

Table 38. Liquidity Check

Liquid?	All Companies		Pure RES		Integrated Companies	
Yes	36	70,6%	15	57,69%	21	84,0%
No	15	29,4%	11	42,31%	4	16,0%
Total	51	100%	26	100%	25	100%

The results for Beta presented in Table 39 and Table 40 suggest that the risk taken by renewable energy companies is lower than that taken by generation only or integrated companies. The possible reasons for this result, is that the market exposure and market risks present in conventional generation projects, are higher than the risk undertaken by RES projects. This has to do with the uncertainty of the market prices and the competitive pressure in a wholesale electricity market. The support schemes to renewables have proved to be effective and have caused the boost in renewable penetration in Europe in the last twenty years.

Table 39. Betas of the industry based on peer group of companies

Period	β_U	β_{RL}	D/E*	Tax Rate*
1 year	0.37	0.79	1.5	25%
3 years	0.38	0.81		
6 years	0.39	0.84		

Table 40. Betas of the industry based on peer group of pure RES companies

Period	β_U	β_{RL}	D/E*	Tax Rate*
1 year	0.30	0.63	1.5	25%
3 years	0.30	0.64		
6 years	0.32	0.67		

Regarding the selection of either the pure or all the companies for the Beta this methodology proposes the use of the second option. The reasons behind this choice lay on the structure of the Spanish market. Most of the main companies belonging to the Spanish RE market (see Table 3) are integrated companies or only their parent company trades in the stock markets. So it is important to include those companies in the calculations even if their incomes are not exclusive from the RES. This choice can be shifted according to the regulator`s expectations at the moment of setting the rate.

5.1.2.5. Market Risk Premium (MRP)

Fournier (2016) concluded that the most suitable approach to the MRP is the use of historical values over expectation polls since it is the most frequently approach used by other European regulators. In addition, with regards to the question of whether using the arithmetic or geometric mean of the excess of market returns with respect to sovereign bonds, it was decided to use the average of both methodologies.

The preferred source for the MRP is the Credit Suisse Global Investments Return Sourcebook 2016 by Dimson, Marsh and Staunton. It is important to recall that the historical analysis carried out by DMS (Credit Suisse, 2016) is constructed upon market data – from different countries – since 1900. Therefore, these results include a period from 1900 up to the most recent year (e.g. 2016 report comprises a study period from 1900-2016).

Finally, the selection of either the Spanish or the European data is a matter of relevance. In addition, the European approach can also be understandable throughout two methods: 1) the single average of European countries, and 2) the weighted average of European countries based on their relative size[28]. The latter approach was considered more suitable for the proposed methodology, so it was selected among these two options.

Regarding the Spanish and European approach, the selection will depend on the assumptions about the expected investors on the Spanish framework; however, based on other countries' regulations and globalization, the European approach would be advisable since global investors would probably base their investments decisions on network utilities at European level.

Table 41. Market risk premium DMS (2016)

Country	Weight	Geometric mean	Arithmetic mean	Average
Austria	1,07%	2,60%	21,50%	12,05%
Belgium	3,67%	2,40%	4,50%	3,45%
Denmark	3,33%	2,30%	3,80%	3,05%
Finland	2,03%	5,20%	8,80%	7,00%
France	18,68%	3,00%	5,40%	4,20%
Germany	17,38%	5,10%	8,50%	6,80%
Ireland	1,02%	2,80%	4,80%	3,80%
Italy	5,07%	3,10%	6,50%	4,80%
Netherlands	4,64%	3,30%	5,60%	4,45%
Norway	2,05%	2,30%	5,20%	3,75%
Portugal	0,57%	2,70%	7,50%	5,10%
Spain	6,51%	1,80%	3,80%	**2,80%**
Sweden	6,20%	3,10%	5,40%	4,25%
UK	27,77%	3,60%	5,00%	4,30%
			Simple Average	4,99%
			Weighted Average	**4,70%**

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[28] Market capitalisation of their Stock Exchange

5.1.2.6. Dividend growth model for Yieldcos

This methodology proposes the calculation of the cost of equity of Yieldcos trading in Europe as an additional reference for the cost of equity of RES generation. As mentioned in section 4.2. Yieldcos own operating electricity generation assets, and therefore produce a (relatively) predictable revenue stream. These assets are not exposed to construction risk, development risk or delay risk, so their cost of equity can only be seen as a floor as well. The cost of equity of the yieldcos is estimated using the Dividend Growth Model (DGM) because the main characteristics of this securities is their high dividends. The results of this calculation are presented in Table 42[29], with an average cost of 5.92%.

Table 42. Cost of equity based on Yieldcos

Name	**Country**	**g**	**Dividend**	**Price**	**Ke**
Atlantica Yield plc	Spain	0%	0,92 €	18,66 €	4,92%
Saeta Yield SA	Spain		0,75 €	8,92 €	8,44%
NextEnergy Solar Fund Ltd	Britain		7,45 €	133,93 €	5,56%
Bluefield Solar Income Fund Ltd	Britain		8,56 €	135,11 €	6,33%
Foresight Solar Fund Ltd	Britain		7,28 €	128,62 €	5,66%
John Laing Environmental Assets Group Lt	Britain		7,22 €	130,39 €	5,54%
Greencoat UK Wind PLC/Funds	Britain		6,34 €	124,00 €	5,11%
Renewables Infrastructure Group Ltd/The	Britain		7,38 €	127,79 €	5,77%
Average					**5,92%**

5.1.3. Cost of debt

The cost of debt refers to the interest paid to financial lenders. It is important to recall that, in case of bankruptcy, debt lenders have priority over investors when getting their money back; therefore, the risk assumed – as the interest demanded – by debt lenders is lower than the one assumed – and demanded – by investors.

As it was presented in Fournier (2016) the Spanish government bonds have had higher rates than the Spanish corporate bonds through part of the period of study, so they cannot be used as the base (risk free rate) for the calculation of the cost of debt. The proposed methodology suggests two approaches regarding the estimation of the cost of debt: Approach 1: The average yield at issue of debt bonds belonging to the peer group; and Approach 2: The sum of a risk free rate plus a debt premium. Later, results from these approaches will be compared against book values.

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[29] A growth rate of 0% has been used to have a conservative scenario.

5.1.3.1. Corporate Bonds

Companies listed in stock markets are able to issue debt bonds as a way of raising funds; the yield at issue of these bonds represent straightforwardly the cost at which utilities are getting financed in debt markets. This approach is in line with previously analyzed methodologies carried out by the CNMC. (E.g. Telecom Sector)

The analysis of debt throughout debt issuances has a couple of drawbacks to take into account: a) they are discrete subjective events which are highly influenced by the financial strategies of companies (they decide the most appropriate time when issuing debt), and b) debt bonds are issued at unstandardized horizons (different maturities).

Analysis of Approach 1 was based on debt bonds issued by the peer group for every period of study. Criteria used at the selection of bonds are the following:

i. Issuer: Bonds issued by both the parent company of the peer companies and its subsidiaries were taken into account.
j. Date: Bonds issued until 30/March/2017 (in accordance with the period of study).
k. Region: Only bonds issued in the countries mentioned in section *Peer* group of companies were selected.
l. Currency: Corporate bonds issued only in euros (€) were taken into account; then, bonds in other currencies were excluded.
m. Maturity: Bonds with a 10-year horizon were taken into account; hence, bonds with a maturity falling outside the 8-12 years range were excluded.
n. Companies rating: Corporate bonds with a lower credit rating[30] than the Spanish rating were excluded.

Table 43. Summary of corporate bonds issued by the peer group

	All companies		Pure RES	
Period	#	Yield	#	Yield
1 year	8	1,22%	0	-
3 years	27	2,24%	0	-
6 years	52	3,11%	1	6,00%

Taking into account the 6-year period, there were found 52 debt bonds belonging to 12 utilities from the peer group of utilities. The average yield from the total bonds is 3.51%; the maximum yield at issue is 6.00% belonging to Alerion Cleanpower SpA (Italy) and issued in February 2015, while the

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[30] Due to the existence of rating discrepancies between the 3 universally recognized rating agencies (Moody's, S&P and Fitch), the 2/3 criteria was used when comparing ratings. In other words, 2 out of 3 credit ratings must not be lower than the Spanish one.

minimum is 1.01% issued by ACEA SpA (Italy) in October 2016. The information regarding pure RES companies is clearly not enough to be considered as valid.

5.1.3.2. IRS+ Debt Premium

According to the European benchmarking analysis performed beforehand in this Master´s thesis and Fournier (2016), it was found that adding a risk free asset and a debt premium is a common practice when estimating the cost of debt.

Fournier (2016) showed that given the Spanish context of high interest rates in the government bonds and the characteristics of the energy sector the best proxy to the cost of debt can be presented in **Equation 5.8.**

$$R_{debt} = IRS_{10Y} + CDS_{10Y} \qquad \textbf{5.8)}$$

Where,

IRS_{10Y}: the RFR is computed from the 10-year EUR Interest Rate Swap[31]

CDS_{10Y}: 10-year CDS from the peer group of utilities.

This approach was based on daily observations[32] of CDS – with a 10-year horizon –belonging to the peer companies. Criteria used at the selection of CDS were similar to the ones used in the selection of bonds:

d. Currency: CDS issued in euros (€) were taken into account.

Companies' rating: CDS belonging to companies with a lower credit rating[33] than the Spanish rating were excluded.

A Summary of CDS from the peer companies is displayed in Table 44. Values regarding averages are measured in basis points. As it was stated before, the continuous nature of CDS allows having much more observations compared to discrete observations from the Bonds approach. Debt premium can be found ranging from 1.27% to 1.44% depending on the relevant investor horizon. As it can be seen, none of the companies with CDS belong to the group of pure utilities, which could suggest a lack of liquidity in those securities.

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[31] This security is found on Bloomberg as "EUSA10 Curncy"

[32] Until 30/March/2017

[33] Same criterion (2/3) was used when comparing ratings

Table 44. CDS values for peer companies

Company	Ticker	6 years	3 years	1 year
Verbund AG	CX410516	97	96	95
SSE PLC	CT373220	129	136	123
DONG	CX352646	115	117	119
Fortum OYJ	CBIR1E10	92	100	106
EDF SA	CEDF1E10	109	114	137
E.ON SE	CEON1E10	105	115	129
ACEA SpA	CX778970	93	93	92
Enel SpA	CENE1E10	205	173	141
EDP	CEPO1E10	307	260	239
Gas Natural	CT400668	199	157	136
Endesa SA	CEND1E10	143	116	121
Iberdrola	CIBE1E10	179	152	123
EnBW	CT403437	97	100	92
Average		144	133	127

Finally, results from both approaches regarding the cost of debt are summarized in Table 45. As it can be observed, corporate bonds issued by the utilities have the same trends that the IRS+CDS approach; therefore, it can be concluded that both approaches might be complementary among themselves. Thus, a plausible suggestion from this proposed methodology would refer taking the mid-point of these two values as the cost of debt of the industry. Next section will compare the results obtained in both approaches against the book values of the peer companies and a recent issue of RE project bonds in Spain. The book value approach will be useful to get more insights about the RES costs of debt.

Table 45. Summary of both approaches (Cost of debt) for all the companies (RES)

	Approach 1	**Approach 2**			**Mid-Point**
Period	Corporate Bonds	IRS 10Y	CDS 10Y	IRS + CDS	Average
1 year	1,22%	0,55%	1,27%	1,82%	1,52%
3 years	2,24%	0,86%	1,33%	2,19%	2,22%
6 years	3,11%	1,53%	1,44%	2,97%	3,04%

Book Values

A supplementary analysis was conducted based on the book values from the peer companies; however, although the proposed methodology is clearly based upon market values, result from this analysis will be useful because of the lack of information regarding pure RES companies.

As mentioned in Fournier(2016), one of the main drawbacks of book values refers to the lack of correspondence with current market debt values; for instance, it could be possible that a given company is still paying nowadays an interest expense from a credit from 25 years ago, where economic situation and debt costs differs from the current conditions.

Data were mainly obtained from Bloomberg. Cost of debt was computed by dividing 1) Interest expense over 2) Total debt. Due to lack of information, the collection of data of interest expense was based on the "Best available data" as explained as follows: first, the Interest Expense (IS_INT_EXPENSE) was sought after, if the value was not available – according to Bloomberg standards – then, the Total Interest Expense[34] (TOT_INT_EXP) was taken; the difference between these two functions is that the latter includes the capitalized interests. Once the cost of capital for every peer utility was found, the average of the industry was estimated.

Results can be seen in Table 46 and Table 47; as it was expected, cost of debt based on book values turned to be higher than values proposed in the two previous approaches.

Table 46. Book Values of Debt (All companies)

Period	**1 year**		**3 years**		**6 years**	
# companies	21		37		38	
Avg. Rate		6,0%		5,8%		5,9%
Std Dev		3,5%		2,9%		2,4%
Max		14,9%		12,1%		11,2%
Min		0,2%		0,2%		0,2%
Austria	1	4,6%	1	5,6%	1	5,3%
Britain	2	9,4%	3	5,3%	3	5,2%
Denmark	2	3,8%	2	4,2%	2	4,6%
Finland	1	3,8%	1	3,8%	1	3,5%
France	3	5,1%	3	4,7%	3	5,4%
Germany	3	7,8%	4	7,3%	4	6,9%
Italy	1	4,6%	12	6,6%	13	6,5%
Portugal	1	5,3%	1	5,3%	1	5,0%
Spain	**6**	**5,6%**	**9**	**5,0%**	**9**	**5,5%**
Sweden	1	9,1%	1	7,6%	1	6,2%

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[34] Total Interest Expense = Interest Expense + Capitalized interest

Table 47 Book Values of Debt (Pure RES)

Period	**1 year**		**3 years**		**6 years**	
# companies	6		17		18	
Avg. Rate		6,86%		6,79%		6,61%
Std Dev		2,6%		2,5%		1,9%
Max		11,2%		12,1%		10,6%
Min		3,6%		3,2%		3,2%
Austria	0	-	0	-	0	-
Britain	2	9,4%	2	7,8%	2	7,6%
Denmark	1	3,6%	1	4,2%	1	4,3%
Finland	0	-	0	-	0	-
France	1	5,2%	1	5,4%	1	6,9%
Germany	0	-	1	8,1%	1	6,8%
Italy	0	-	8	7,3%	9	6,9%
Portugal	0	-	0	-	0	-
Spain	**2**	**6,8%**	**4**	**5,8%**	**4**	**6,0%**
Sweden	0	-	0	-	0	-

As said before, the magnitude of these costs of debt cannot be taken into account. But there is one interesting fact that must be highlighted: the cost of debt for the pure RES companies is higher in all cases than the peer group of all companies. This relationship is summarized in Table 48 and suggests that companies in the pure RES group acquire debt obligations 15% more expensive in average than the companies in the peer group that includes all companies.

Table 48 Book values Pure RES vs All

Period	**1 year**	**3 years**	**6 years**
All Companies	6,01%	5,80%	5,87%
Pure RES	6,86%	6,79%	6,61%
RES/ All	**1,14**	**1,17**	**1,13**

This result will be used as a way to get an approximation of the cost of debt for the pure RES companies since the market values found are clearly not enough to get a solid figure. This methodology proposes to increase the cost of debt of the peer group in 15% to get the cost of debt that represents the Pure RES companies. The cost of debt of the pure RES companies following this approach can be seen in Table 49.

Table 49. Cost of debt Pure RES companies

Period	**Mid-Point** All companies	**Mid-Point** RES
1 year	1,52%	1,75%
3 years	2,22%	2,55%
6 years	3,04%	3,49%

Project bonds in the Spanish market

The Spanish renewable energy company Vela Energy has recently successfully closed the issuance of its €404.4 million non-recourse project bond, the largest issuance in the European photovoltaic sector as of May 2016. The proceeds from the issuance will be mainly used to refinance existing obligations of 35 solar photovoltaic projects in Spain, which produce 157.3 GWh annually (Vela Energy, 2016). Vela's non-recourse project bond has a 3.195% coupon, a 20 year maturity (June 2036) and has been rated "BBB stable" by Standard & Poor's. There is not market information about the issuance of the bond, but with the assumption that the yield at issue date is equal to the annual coupon of the bond, the 3.195% rate is in line with the results obtained through this methodology for the 6 years period.

5.1.4. Additional Risks

As mentioned before, in this work the CAPM/WACC model has been complemented to include some additional risks as a spread added to the WACC. Two types of risks have been identified within this group: asymmetric risks and price risk.

5.1.4.1. Asymmetric Risks

In spite of its extensive use, the CAPM has a number of weaknesses that make it unsuitable as the only model for calculating the allowed rate of return for investments in renewable energy generation projects. For example, NERA (2015) mentions that as a one-period model, the standard CAPM framework does not capture the resolution of uncertainty over time. Moreover, the CAPM assumes that the distribution of returns is symmetric (One requirement of the model is that the error terms are random and normally distributed around the characteristic line), implying that investors are equally exposed to upside and downside risks, which need not be the case for all types of risks. Capturing these effects is necessary in order to fully explain the rate required by renewable generation investors. To overcome this situation, the CAPM framework has been expanded to include asymmetric risk.

In the context of investments in assets where the cash flows are not set by the market (e.g. Spanish remuneration scheme to renewables), "asymmetric risk" usually refers to a situation where the "base case" for revenues / costs chosen by the regulator is more optimistic than the expected case. In that context, regulatory choice can lead to expected under-recovery of cost. In principle, such a situation can be remedied by using a central case that properly reflects expected value. However, forecasting the expected values can be difficult or might not be possible to do. As a result some regulators have chosen to adjust the allowed rate of return with an explicit mark-up on the CAPM, as opposed to the central cost/revenue forecast, which (when done correctly) has the same effect. (Synergies, 2009)

In order to do so, two major asymmetric risks have been identified in the framework of this work:

Delay Risk: the risk arising from the possibility of construction delays of a project. Specifically, under the current legal framework (Real Decreto 413/ 2014) developers face the risk of loss of support if commissioning is delayed beyond one month after the deadline for the registration in the "specific remuneration regime" record. This risk has all the characteristics of an asymmetric risk on the downside. If the developers register the plant before the due date there is no reward or additional compensation, but in case of a minor delay the support scheme is removed.

Technology Risk: the risk of unforeseen underperformance of technical equipment or higher costs than expected to maintain expected performance, as generation with renewable sources doesn´t have an extended track-record of performance through decades as other mature technologies such as those employed in transmission and distribution do. Uncertainties arise due to the lack of adequate resource assessment for future potential or the use of new technologies. While there is no a priori reason to believe such underperformance or cost escalations are more likely to occur in an economic downturn than upturn, a Synergies Economic Consulting Report (2009) notes that such risks generally pose an asymmetric downside without a commensurate upside. This risk is especially important in some technologies that have not reached maturity yet, such as offshore wind, marine energy and carbon capture and storage (CCS) technologies. (DiaCore, 2016)

5.1.4.2. Price Risk

As mentioned in section 3.2.1., the income of RES generators depend partially on the price the project can sell the electricity produced for. Due to high volatility in electricity prices, this is a risk investors try to mitigate in favor of fixed pricing. This is the reason why the government has stablished an adjustment mechanism, that covers electricity prices falling outside pre-stablished price bands. This feature implemented in the Spanish regulatory system aims to account for that desired stability. It is true that the deviations in the mean price from the forecasted price are compensated if they fall outside of the price bands, but some elements should be highlighted:

- the compensation is differed on time, so it will not take place during the year when the deviations actually occur but during the remaining lifespan of the project;
- the compensation may not allow the projects to recover the reasonable rate of return in case actual price at the end of the year is under the forecasted price (The compensation mechanism does not account for the whole difference between the forecasted price and the actual price, but for a smaller value, as differences within the lower price bands are not compensated, and within the upper price bands are only 50% compensated);

- other countries schemes researched in the benchmarking (i.e. German Feed in Premiums and British CfDs) have support schemes that guarantee a fixed price of electricity to RES projects, with either complete market premiums (difference between a monthly estimated price and the real price) or financial hedging mechanisms.

As a result of the previous considerations, it has been considered that an additional premium accounting for the price risk could be added to the CAPM/WACC methodology.

5.1.4.3. Assessment of the Risks

According to the benchmarking research, these risks have been usually assessed through surveys to stakeholders of the renewable energy projects (analysts, banks, developers, consultants, academics, etc). For the purpose of this work, reference values taken from other studies will be used. Although as a way to improve the results, it is suggested to perform surveys when setting the rate of return in 2018. Modelling the cash flows of the projects is also strongly suggested as an improvement of this work. In the light of the previous discussion, some insights for the spreads have been obtained from three sources: NERA (2016), DiaCore (2016) and (IEA, 2011) . Table 50 summarizes the results of the different reports studied. DiaCore and NERA provide a quantitative assessment based on surveys on stakeholders and IEA (2011) provides a single qualitative assessment and a mixed quantitative assessment based on probabilistic models. The results of the single analysis is used for this work.

Table 50 Assessment of Additional Risks in Literature

DiaCore (2016)	NERA (2016)	IEA (2011)
+ 3% spread on the cost of debt for “RES project risk". (Approx. 1.3% effect on the WACC)*	+ 0.25% novelty premium (Technology risk) + (0.5 to 1 %) delay risk depending on the technology	• Price risk: assessed as **high** for all the technologies. • Delay risk: assessed as **high** for all technologies. • Technology risk: **low or medium** depending on technologies

* With 25% tax and 60/40 debt leverage

After analyzing the sources, a qualitative assessment is presented in Figure 13. It shows the likelihood and the impact of the risks over the projects.

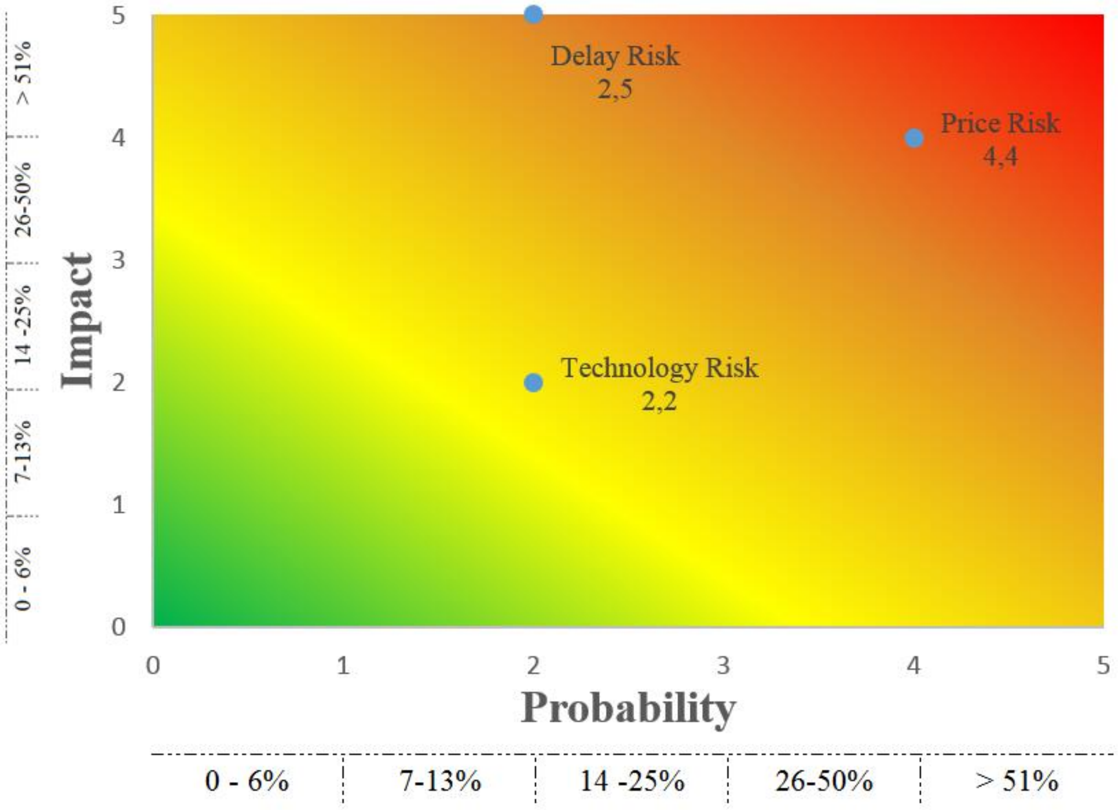

Figure 13 Heat Map Additional Risks RES

Delay risk: seems to be unlikely (15% to 25% of occurrence probabilities depending on the source) but its effect on the project revenues is significant. It would imply losing stability and affecting the revenue streams in more than 50% in some scenarios because the projects would rely only on market prices. With a growing renewable penetration, relying on the market may seem risky for some investors. Taking into account the qualitative assessment, the delay rate of previous projects (approx. 50% when the penalties were not so strong), the values from the benchmarking , and the proportion of new expected projects in relation with the existing ones, a 30bps spread seems a good proxy of the Delay risk.

Technology Risk: Meanwhile the technology risk is one of the most important in non-mature technologies such as offshore wind or marine energy, but it is not so significant in more mature and widespread technologies such as solar PV and onshore wind. This risk is not considered as a big concern because of the limited deployment of new technologies, although it must considered in the calculations. A 10 bps spread will be considered for this work.

Price Risk: this risk has a high likelihood (the possibility of having the very same average price than the one forecasted for the year is very low), and a medium impact, as the deviation between the actual and the forecasted price not covered by the adjustment mechanism can be up to 12% (based on the values of the price bands for last auction stablished by Orden ETU/315/2017, dated 6th April 2017). A quantitative assessment can be performed taking into account hedging costs (for example, if a project wants to have complete hedging against price risk they can go to a derivate market and buy the respective financial securities). In this work, a 40 bps spread has been considered.

As a result, the spread comprising the specific risks is represented in Table 51. It is important to recall that the spread is to be added to the ‘after-tax' cost of capital.

Table 51. Quantitative Assessment of Risks

Risk	Spread
Delay Risk	30 bps
Technology Risk	10 bps
Price Risk	40 bps
Total	**80 bps**

5.2. Allowed rate of return for generation in isolated energy systems

Isolated energy systems are a challenging task with regards to the characterization of the rate of return that investors should earn. So far, various elements of these systems have been described in previous sections. Moreover, a European benchmarking study has been conducted. On that point, it is important to recall that Royal Decree 738/2015 establishes some characteristics that the remuneration rate should reflect:

a) Adequate remuneration for a low risk activity considering the financial situation of the electricity system and the cyclical situation of the Spanish economy.

b) Cost of financing of electricity generation companies with regulated remuneration schemes, based on the recognition of a rate of return for investments and operating expenses of efficient and well-managed companies.

It is a goal of this work to provide a rate of return that is in line with the aforementioned requirements. The second one, regarding financing costs of generation companies in regulated environments, it is not possible to fulfil it completely, because of the lack of suitable benchmarking. In first place, there is only one generation company (Endesa Generación) operating in the isolated systems in Spain, directly in Ceuta and Melilla, and indirectly through its subsidiaries GESA in the Balearic Islands and UNELCO in the Canary Islands. This company, as seen before, belongs to a holding – ENDESA - active in different business (Conventional generation, renewable generation, distribution and retailing). The latter creates the need to look for a peer group of companies (As it was done in T&D and RES generation), which in turn is not possible since there are not European generation companies exclusively working on isolated energy systems, that have regulated schemes like the Spanish one.

The French regulatory framework regarding Corsica may seem similar to the Spanish case, although it was not possible to find the methodology upon which the rate of return (11%) was established, nor the reviewing mechanism was found (in practice, it hasn´t been reviewed sin 2006). In addition to this, the generation company (EDF) has worldwide operations, so its financial statements do not reflect correctly the operations of a company solely working on isolated energy systems. Other cases, like Sicily or Crete are not comparable to the Spanish Systems, since there are established electricity markets in those systems with support mechanisms, none of which take into account a regulatory framework for investment recovery like the one set in Spain (with amortization and rate of return on the investments pending to recover.

As a result of this limitation, it is necessary to look for an alternative approach that allows to get a rate of return that can account of the risks and particularities of the generation business in isolated energy systems. After a profound analysis the alternative chosen is to provide the isolated systems with the same rate of return as the T&D activities. This measure is already used in the Spanish regulation, in which both activities (T&D and Isolated Energy Systems) have the same rate of return. In fact, although article 28 of Royal Decree 738/2015 makes a reference to *“electricity generation companies with regulated remuneration schemes”*, its preamble stablishes that the rate of return *“would be similar to the rest of regulated activities”*, being those T&D.

There are some arguments that support this choice based on the similarities of both activities in terms of investment recovery framework, but there are also some differences that must be discussed in this document in order to show that they do not represent major issues when setting the same rate of return.

Similarities between T&D and Isolated Energy Systems (Risks and Remuneration)

- Regulated incomes: in both cases the whole of the incomes are regulated and do not come from any market basis. The regulator acknowledges the costs of operation and maintenance according to the terms in the law – being those related to an efficient and well-managed company.
- Fixed costs / Investments are recovered with a financial rate of return (having being the same for the first regulatory period – ending 2019).
- Low risk businesses: the regulation (Ley 24/2013, 2013) states that transmission, distribution and energy generation in the isolated systems should be remunerated considering their characteristics of “low risk activities”.
- No change greater than 50 bps between two consecutive years in the rate of return is allowed. In case the rate of return is reviewed for the next regulatory period, increasing or decreasing more than 50 bps, the change would have to be implemented gradually in the number of years necessary to achieve the targeted rate of return.
- Rate of returns must be consistent with the economic cycles and fixed every six years

Differences between T&D and Isolated Energy Systems (Risks and Remuneration)

- Failure rate in generation facilities is higher than in T&D activities: as shown in (Roos & Lindahl , 2010) T&D assets present failure rates in average of 0.5%, which is much lower than the 3% to 5% typical forced outage rates of conventional generation plants. This issue is solved through the availability incentives presented below.

- There are availability incentives in the Isolated Energy Systems: as shown in section 3.2.2. the remuneration of the fixed costs is given by **Equation 5.9**

$$FC_{y,i} = \min\left(A_{y,i}, \sum_{h=Y_i}^{h=X_i} \boldsymbol{AP_{i,h}} * FC_{i,h,y} \right) \qquad \mathbf{5.9})$$

where $\boldsymbol{AP_{i,h}}$ is the available power of the generation facilities at any given hour of the year and $FC_{i,h,y}$ is an adjustment coefficient that controls for seasonality and peak-valley hours. (The rest of the definitions can be checked on section 3.2.2.) . This is a clear incentive to keep the plants available during the hours of highest demand. Such type of incentive is not implemented in the T&D remuneration scheme. At first sight this mechanism would imply higher risks (and then higher return) for generation activities in comparison with T&D specially taking into account the higher failure risk of generation units discussed in the previous point. Although, after a qualitative analysis, this mechanism has been interpreted as a way of encouraging plants to have maintenance stops only during the seasons and hours of lowest demand. The $FC_{i,h,y}$ element is adjusted by a coefficient (see **Equation 3.6**) according to the season that provides big incentives to keep the plants online during peak demand seasons. By doing so, the operators have an amount of hours that they can have maintenance at, without losing any income. In other words, by keeping the plants on during the time of higher demand, the plants *"earn credits"* to be off-line during the time of lowest demand, without losing incomes.

Update of relevant parameters

In Fournier (2016), a framework was developed for understanding the rate of return for transmission and distribution activities. In this analysis, we maintain that framework, described in Chapter 5, and the only change that is made is the addition of the liquidity test presented for RES activities. The liquidity check is presented in Table 52 and the details can be found in Annex 1.

Table 52 Liquidity Check T&D Companies

Liquid?	All Companies		Pure Networks		Integrated Companies	
Yes	26	86,7%	8	100,00%	18	81,8%
No	4	13,3%	0	0,00%	4	18,2%
Total	30	100%	8	100%	22	100%

The update for the cost of debt is presented in Table 53 and the values are slightly lower than in the RES case.

Table 53. Cost of debt T&D

	Approach 1	Approach 2			Mid-Point
Period	Corporate Bonds	IRS 10Y	CDS 10Y	IRS + CDS	Average
1 year	1,13%	0,55%	1,38%	1,93%	1,53%
3 years	1,65%	0,86%	1,39%	2,25%	1,95%
6 years	2,62%	1,53%	1,47%	3,01%	2,81%

Finally the update of the beta coefficients can be seen in Table 54 and Table 55.

Table 54. Updated Beta for T&D (All companies)

Period	**Bu**	**Brl**	**D/E***	**Tax Rate***
1 year	0.39	0.68	1	25%
3 years	0.39	0.69		
6 years	0.39	0.68		

Table 55. Updated Beta for T&D (Pure Network Companies)

Period	**Bu**	**Brl**	**D/E***	**Tax Rate***
1 year	0.35	0.61	1	25%
3 years	0.33	0.58		
6 years	0.30	0.52		

5.3. Remuneration of Smart Grids investments

Since the remuneration scheme for T&D activities does not recognize any differentiated rate of return (or any other specific compensation mechanism) for innovate investments, it is out of the scope of this work the proposal of a methodology to approximate rates of return for those particular investments. This work will rather provide some general recommendations and insights for the regulator and policy makers towards the path to be followed. In most of the European countries, the smart grids investments are treated like any other investment and are added to the RAB. As mentioned in section 3.2.3. Spain is among those countries where there is no particular support mechanism. Nevertheless, the benefits of innovation and smart grids are widely known and some countries have already started to incentivize these investments.

The first element that has to be acknowledged is that smart grids investments involve higher risks in testing new technologies and processes. The technologies and systems that will be most efficient for facilitating active network management in distribution networks with high penetrations of distributed energy resources are simply not known today. (MIT- ICAI, 2016). Therefore, there is a need for greater investment in demonstration projects and accelerated knowledge-sharing or “spillovers” among utilities. This will involve undertaking experimental projects where the potential cost savings are inherently uncertain, may only be realized in the medium to long term, if at all, and may not fully accrue to the utility incurring the costs due to spillover. However, despite the need for increased levels of long-term innovation, spending on research, development, and demonstration (RD&D) by network utilities has been declining. The reason behind these results is that the current regulatory frameworks in Europe do not adequately incentivize these types of risky projects and the technological learning that emerges from them (MIT- ICAI, 2016).

With the objective of solving this situation, some countries have incentive mechanisms developed to support pilot investments in new technologies. Two types of mechanisms have been mainly used: (1) the provision of higher rates of return (i.e., adding an extra component to the regulatory WACC), and (2) the adjustment of revenues (i.e., providing an extra allowance or specific rewards due to performance targets). (Cambini, et al., 2016).

In Portugal, the regulator allows the DSO a 1.5% premium return on “smart” investments if the project is expected to provide for an overall efficiency gain, with OPEX savings over time compensating for the initial additional CAPEX. Similarly, in Italy, AEEG (2012-2015 regulatory period) introduced a competition based procedure providing specific incentives for innovative demonstration projects related to the active distribution network. To generate interest by DSOs, these pilot programs allowed for a 2% premium over the cost of capital for a limited time period of 12 years. On the other hand, the adjustment of revenues has been performed differently by each country (UK, Slovenia, Finland, Austria, Norway and France) but mainly through pilot projects and efficiency incentives applied to the DSOs.

Because of the nature of the Spanish regulatory framework, it seems easier to apply the extra WACC approach to incentivize smart grids investments. This could be done in the way of pilot projects as it was done in Italy and then, after the assessment of the results other methodologies could arise. The magnitude of the spread that could be applied to the WACC of T&D is not easy to quantify. Ex ante, and just based on other successful experiences, the magnitude could be around 1% to 2%.

It is necessary to develop further studies to assess the best methodology and the details of a possible remuneration to these “smart” investments. But the fact is that there are new regulatory tools being developed that could fit the Spanish case in the pursuit of the objectives in terms of quality and adaptation to the penetration of distributed generation resources.

Chapter 6

6.Results through Case Studies

6.1. Numerical application of the proposed methodology

This section will provide two case studies (RES generation and Generation in isolated energy systems) according to the objectives presented in Section 1.2. Results of this research are in line with the final proposition of WACC and its transformation to an allowed rate of return in accordance to the methodology developed in Chapter 5. In each case, a group of scenarios will be analyzed based on different possibilities in the parameters. In first place two assumptions regarding the expected investors will be presented; the first scenario will consider only international investors focusing on European market returns, while the second scenario (based on the home bias effect) will only assume Spanish investors, so Spanish market premium should be considered. Second, the final approach for the cost of debt will be discussed based on the two possible approaches presented in Chapter 5. In addition, the results will be presented for the two possible approaches to the risk free rate: historical values and forward looking values. Among the periods of study proposed, 3-year and 6-year periods will be analyzed in order to give a conclusive proposal for the methodology. 1-year period will also be analyzed to present current market conditions.

Results will be compared against reference values (e.g. the current rate of return) and will also be estimated based on the peer group of pure companies in order to provide a better understanding of the achieved results. As explained in section 5.2 the methodology used for the rate of return in the isolated energy systems is based on Fournier (2016) methodology for Transmission and Distribution complemented with a liquidity check.

6.1.1. Renewable generation

Main Scenario

This main scenario assumes the expectation of international investors – no home bias effect – in the Spanish industry; therefore, the European market risk premium is chosen in this first step. In addition the peer group of companies preferred includes both pure RES and companies with diversified revenues. As stated in section 5.1.2.4 , the reason behind this choice lays on the structure of the market.

Regarding the period of study, as suggested by Fournier (2016) it should be related to the expected economic conditions during the next regulatory period; moreover, it seems plausible to use the 6-year period for the following reasons: 1) it assumes a moderate and cautious approach regarding the economic perspective; 2) it corresponds exactly to one regulatory, and 3) average length of economic cycles – in the last 65 years – is around 70 months (almost 6 years).

Cost of debt

Concerning the cost of debt, two approaches to estimate the cost of debt were suggested; however, there was no conclusive decision whether to use one or another (See Table 45). Therefore, numerical results using both approaches are analysed in Table 56 and Table 57, respectively.

Table 56. RES results using IRS+ CDS

		1 year	**3-years**	**6 years**	**Notes**
Risk Free Rate (CoE)	[1]	1,37%	1,79%	3,46%	10 year Spanish Bond
Beta	[2]	0,79	0,81	0,84	Beta
Market Risk Premiun	[3]	4,70%	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	**5,10%**	**5,61%**	**7,39%**	1+ (2 X3)
Risk Free Rate (CoD)	[5]	0,55%	0,86%	1,53%	10 YEAR IRS
Debt Premium	[6]	1,27%	1,33%	1,44%	CDS COMPANIES
Pre tax Cost of Debt	[7]	**1,82%**	**2,19%**	**2,97%**	5+6
TAX RATE	[8]	25%	25%	25%	
D/(E+D)	[9]	60%	60%	60%	
Additional Risks Spread	[10]	0,80%	0,80%	0,80%	
Nominal Post Tax WACC + Risks	[11]	3,66%	4,03%	5,09%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9]) +[10]
Pre tax allowed rate of return	[12]	**4,88%**	**5,37%**	**6,79%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	309	359	500	[12]-[13]

Table 57 RES results using Corporate Bonds

		1 year	**3-years**	**6 years**	**Notes**
Risk Free Rate (CoE)	[1]	1,37%	1,79%	3,46%	10 year Spanish Bond
Beta	[2]	0,79	0,81	0,84	Beta
Market Risk Premiun	[3]	4,70%	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	**5,10%**	**5,61%**	**7,39%**	1+ (2 X3)
Risk Free Rate (CoD)	[5]				
Debt Premium	[6]	1,22%	2,24%	3,11%	Corporate Bonds
Pre tax Cost of Debt	[7]	**1,22%**	**2,24%**	**3,11%**	5+6
TAX RATE	[8]	25,00%	25,00%	25,00%	
D/(E+D)	[9]	60%	60%	60%	
Additional Risks Spread	[10]	0,80%	0,80%	0,80%	
Nominal Post Tax WACC + Risks	[11]	3,39%	4,05%	5,15%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9]) +[10]
Pre tax allowed rate of return	[12]	**4,52%**	**5,40%**	**6,87%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	273	361	509	[12]-[13]

Taking into account both approaches, it is possible to identify a range of the pre-tax allowed rate of return based on the 6-year period; the lower bound is found around 6.79%, while the upper bound around 6.87%. Since both approaches seem to be suitable for the methodology and they represent the different financing costs of the corporations, this methodology (as done in Fournier (2016)) proposes the mid-point of this range as the best estimation of the pre-tax allowed rate of return (see Table 58);

however, it is a decision to be made by regulator which value to select, and if it should be closer to any of these two figures.

Table 58. RES results using Mid-Point of both debt approaches

		1 year	**3-years**	**6 years**	**Notes**
Risk Free Rate (CoE)	[1]	1,37%	1,79%	3,46%	10 year Spanish Bond
Beta	[2]	0,79	0,81	0,84	Beta
Market Risk Premiun	[3]	4,70%	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	**5,10%**	**5,61%**	**7,39%**	1+ (2 X3)
Risk Free Rate (CoD)	[5]				
Debt Premium	[6]	1,52%	2,22%	3,04%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	**1,52%**	**2,22%**	**3,04%**	5+6
TAX RATE	[8]	25,00%	25,00%	25,00%	
D/(E+D)	[9]	60%	60%	60%	
Additional Risks Spread	[10]	0,80%	0,80%	0,80%	
Nominal Post Tax WACC + Risks	[11]	3,52%	4,04%	5,12%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9]) +[10]
Pre tax allowed rate of return	[12]	**4,70%**	**5,39%**	**6,83%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	291	360	505	[12]-[13]

To summarize this point, the main scenario will be defined by the elements presented in Table 59 and its characteristics will be used in the following scenarios unless otherwise is mentioned.

Table 59. Main Scenario Assumptions

Element	Main Scenario assumption
Period of Study	6 years
Cost of debt	Midpoint of both approaches
Investors Profile	International
Risk free rate	Historical (6 years)
Peer Group	All companies

Pure RES vs All

Another possible scenario to be analyzed is the possibility of using only pure RES companies in the peer group of companies. This scenario makes sense since the allowed rate of return is aimed exclusively to RES projects. There are two differences in this case: the Beta coefficients [2] and the cost of the debt [6]. In this scenario the allowed rate of return decreases by approximately 35 bps, from 6.83% to 6.48%.

Table 60. RES results All peer companies vs Pure RES

		All	Pure	Notes
Risk Free Rate (CoE)	[1]	3,46%	3,46%	10 year Spanish Bond
Beta	[2]	0,84	0,59	Beta
Market Risk Premiun	[3]	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	7,39%	6,22%	1+ (2 X3)
Risk Free Rate (CoD)	[5]			
Debt Premium	[6]	3,04%	3,49%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	3,04%	3,49%	5+6
TAX RATE	[8]	25%	25%	
D/(E+D)	[9]	60%	60%	
Additional Risks Spread	[10]	0,80%	0,80%	
Nominal Post Tax WACC + Risks	[11]	5,12%	4,86%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9]) +[10]
Pre tax allowed rate of return	[12]	**6,83%**	**6,48%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	505	470	[12]-[13]

International investors Profile vs Home Bias

The purpose of this supplementary scenario is to provide a sensibility analysis with regard to the main scenario assuming the existence of the home bias effect in the Spanish investment framework. It is important to recall that this effect refers to the fact that investors tend to invest in securities from their same country due to their market knowledge and the existence of transactions costs. Thereupon, the following two assumptions will be considered: 1) only Spanish investors are expected to invest in Spanish RE projects, and 2) they are not interested to place their money outside Spain. The only parameter that changes is the market risk premium [3], from 4.7% in the main scenario to 2.8% in the home bias case. Table 61 shows the numerical results from both scenarios.

Table 61. Home Bias vs International investors´ scenario (RES)

		Main	Home	Notes
Risk Free Rate (CoE)	[1]	3,46%	3,46%	10 year Spanish Bond
Beta	[2]	0,84	0,84	Beta
Market Risk Premiun	[3]	4,70%	2,80%	MRP DMS - WEIGHTED vs SPANISH
Nominal after-tax cost of Equity	[4]	7,39%	5,80%	1+ (2 X3)
Risk Free Rate (CoD)	[5]			
Debt Premium	[6]	3,04%	3,04%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	3,04%	3,04%	5+6
TAX RATE	[8]	25%	25%	
D/(E+D)	[9]	60%	60%	
Additional Risks Spread	[10]	0,80%	0,80%	
Nominal Post Tax WACC + Risks	[11]	5,12%	4,49%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9]) +[10]
Pre tax allowed rate of return	[12]	**6,83%**	**5,98%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	505	420	[12]-[13]

Forward looking Risk Free Rate (RFR)

As mentioned in section 5.1.2.3 there are two possible ways in which the risk free rate used in the CAPM for the Cost of Equity (CoE) can be obtained. In this scenario the results are gotten using the alternative methodology proposed by CNMC in the airport sector. The RFR [1] decreases from 3.46% (value from the main scenario based on 6 years observations of the 10 years Spanish Bond) to 2.38%. As expected, all the results from this scenario are lower compared to the main case. Two more sensibility situations using the forward looking RFR are presented in Table 62: the home bias case and the use of only pure RES companies for the Beta.

Table 62. RES scenarios using the Forward Looking RFR

		Main*	**Home**	**Pure**	**Notes**
Risk Free Rate (CoE)	[1]	2,38%	2,38%	2,38%	10 year Spanish Bond (Forward looking approach)
Beta	[2]	0,84	0,84	0,59	Beta
Market Risk Premiun	[3]	4,70%	2,80%	4,70%	DMS MRP (Home Bias or International)
Nominal after-tax cost of Equity	[4]	6,31%	4,72%	5,14%	1+ (2 X3)
Risk Free Rate (CoD)	[5]				
Debt Premium	[6]	3,04%	3,04%	3,49%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	3,04%	3,04%	3,49%	5+6
TAX RATE	[8]	25%	25%	25%	
D/(E+D)	[9]	60%	60%	60%	
Additional Risks Spread	[10]	0,80%	0,80%	0,80%	
Nominal Post Tax WACC + Risks	[11]	4,69%	4,05%	4,43%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9]) +[10]
Pre tax allowed rate of return	[12]	**6,25%**	**5,41%**	**5,90%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	447	362	412	[12]-[13]

* Using the forward looking RFR and the rest of the parameters from the main scenario

Summary of Results

Up to this point, several analyses were carried out taking into consideration the following key issues: 1) Cost of Debt, 2) Peer group of companies, 3) Type of investor, and 4) Risk Free Rate. Table 63 shows the process followed when obtaining the conclusive outcomes for each relevant issue proposed in this work.

Regarding the first point, both approaches for the cost of debt were compared. As it cannot be possible to select one over another (since both approaches seem to properly represent the cost of debt of the industry at stake) the methodology proposes the mid-point (6.83%) from the range obtained as the conclusive outcome; moreover, the spread (0.08%) between both alternatives seems small so the mean value can be considered as a good proxy.

Later, an additional analysis concerning the type of companies provides insights regarding the relevant allowed rate of return that pure RES companies should receive (6.21%); due to their lower risk profile, their rate of return should correspondingly be lower. However and as previously announced, this value is only considered as a reference since the peer group of pure companies used for this analysis left out the main players in the RES sector in Spain. Thus, the value estimated using the peer group of (all) companies (6.83%) remained as the conclusive outcome for the practical purposes of this methodology.

Then, an additional exploration was carried out regarding different scenarios concerning the expectations on the potential investors in the Spanish RES sector during the next regulatory period (2020-2025); while the international approach (used in previous analysis: 6.83%) considers global investors who evaluate their investment projects at European level, the home bias approach assumes that only local (Spanish) investors will be relevant for the industry. Outcome (considering the Spanish MRP) was 5.98%. Nonetheless, since the main scenario (global investors) seemed to be more robust based on European experience; the conclusive outcome also remained on 6.83%.

Finally, the results were analyzed in the case of using the Forward looking RFR. This methodology prefers the historical risk free rate because of the reasons presented in section 5.1.2.3 and amongst others because it works as a "correction mechanism" at the end of each regulatory period. This yields a rate of return of 6.83% and in case of using the forward looking rate the value falls to 6.25%. In any case, the methodology proposed considers that all results should be presented to provide the regulator with tools at the moment of making the decision.

Table 63 Conclusive outcomes derived from the analyses performed (RES)

	Alternatives			**Outcome**
Period of Study	3-year	vs	6-year	6 years
Bonds	5,40%		6,87%	6,87%
IRS+CDS	5,37%		6,79%	6,79%
Cost of Debt	Bonds	vs	IRS+CDS	Mid-Point
	6,87%		6,79%	6,83%
Type of Utilities	Pure	vs	All	All
	6,21%		6,83%	6,83%
Investors	International	vs	Home Bias	International
	6,83%		5,98%	6,83%
Risk Free Rate	Historical (6Y)	vs	Forward Looking	Historical (6Y)
	6,83%		6,25%	6,83%

6.1.2. Generation in isolated systems / Transmission and Distribution

The procedure followed in this section is similar to the one performed in RES generation. There will be a main scenario defined by the elements of Table 59 and some alternative scenarios will be presented in order to provide more details that can help the regulator made the final choice.

Cost of debt

Table 64. T&D Results using Corporate Bonds

		1 year	3-years	6 years	Notes
Risk Free Rate	[1]	1,37%	1,79%	3,46%	10 year Spanish Bond
Beta	[2]	0,68	0,69	0,68	Beta
Market Risk Premiun	[3]	4,70%	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	4,57%	5,02%	6,67%	1+ (2 X3)
Risk Free Rate	[5]				
Debt Premium	[6]	1,13%	1,65%	2,62%	Corporate Bonds
Pre tax Cost of Debt	[7]	1,13%	1,65%	2,62%	5+6
TAX RATE	[8]	25,00%	25,00%	25,00%	
D/(E+D)	[9]	0,5	0,5	0,5	
D/E	[10]	1,0	1,0	1,0	
Nominal Post Tax WACC	[11]	2,71%	3,13%	4,32%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9])
Pre tax allowed rate of return	[12]	**3,61%**	**4,17%**	**5,76%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	183	238	397	[12]-[13]

Table 65. T&D results using IRS+ CDS

		1 year	3-years	6 years	Notes
Risk Free Rate	[1]	1,37%	1,79%	3,46%	10 year Spanish Bond
Beta	[2]	0,68	0,69	0,68	Beta
Market Risk Premiun	[3]	4,70%	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	4,57%	5,02%	6,67%	1+ (2 X3)
Risk Free Rate	[5]	0,55%	0,86%	1,53%	IRS
Debt Premium	[6]	1,38%	1,39%	1,47%	CDS
Pre tax Cost of Debt	[7]	1,93%	2,25%	3,01%	5+6
TAX RATE	[8]	25,00%	25,00%	25,00%	
D/(E+D)	[9]	0,5	0,5	0,5	
D/E	[10]	1,0	1,0	1,0	
Nominal Post Tax WACC	[11]	3,01%	3,35%	4,46%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9])
Pre tax allowed rate of return	[12]	**4,01%**	**4,47%**	**5,95%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	223	268	417	[12]-[13]

Table 66. T&D results using Mid-Point of both debt approaches

		1 year	3-years	6 years	Notes
Risk Free Rate	[1]	1,37%	1,79%	3,46%	10 year Spanish Bond
Beta	[2]	0,68	0,69	0,68	Beta
Market Risk Premiun	[3]	4,70%	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	4,57%	5,02%	6,67%	1+ (2 X3)
Risk Free Rate	[5]				
Debt Premium	[6]	1,53%	1,95%	2,81%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	1,53%	1,95%	2,81%	5+6
TAX RATE	[8]	25%	25%	25%	
D/(E+D)	[9]	0,5	0,5	0,5	
D/E	[10]	1	1	1	
Nominal Post Tax WACC	[11]	2,86%	3,24%	4,39%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9])
Pre tax allowed rate of return	[12]	**3,81%**	**4,32%**	**5,86%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	203	253	407	[12]-[13]

Pure vs All

Table 67 T&D results: All peer companies' vs Pure T&D

		All	**Pure**	**Notes**
Risk Free Rate	[1]	3,46%	3,46%	10 year Spanish Bond
Beta	[2]	0,68	0,52	Beta
Market Risk Premiun	[3]	4,70%	4,70%	MRP DMS - WEIGHTED
Nominal after-tax cost of Equity	[4]	6,67%	5,90%	1+ (2 X3)
Risk Free Rate	[5]			
Debt Premium	[6]	2,81%	2,55%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	2,81%	2,55%	5+6
TAX RATE	[8]	25%	25%	
D/(E+D)	[9]	0,5	0,5	
D/E	[10]	1	1	
Nominal Post Tax WACC	[11]	4,39%	3,91%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9])
Pre tax allowed rate of return	[12]	**5,86%**	**5,21%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	407	342	[12]-[13]

International vs home bias

Table 68 Home Bias vs International investors´ scenario (T&D)

		Main	**Home**	**Notes**
Risk Free Rate	[1]	3,46%	3,46%	10 year Spanish Bond
Beta	[2]	0,68	0,68	Beta
Market Risk Premiun	[3]	4,70%	2,80%	MRP DMS - WEIGHTED vs SPANISH
Nominal after-tax cost of Equity	[4]	6,67%	5,37%	1+ (2 X3)
Risk Free Rate	[5]			
Debt Premium	[6]	2,81%	2,81%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	2,81%	2,81%	5+6
TAX RATE	[8]	25%	25%	
D/(E+D)	[9]	0,5	0,5	
D/E	[10]	1	1	
Nominal Post Tax WACC	[11]	4,39%	3,74%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9])
Pre tax allowed rate of return	[12]	**5,86%**	**4,99%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	407	320	[12]-[13]

Forward looking Risk Free Rate (RFR)

Table 69. T&D scenarios using the Forward Looking RFR

		Main*	**Home**	**Pure**	**Notes**
Risk Free Rate (CoE)	[1]	2,38%	2,38%	2,38%	10 year Spanish Bond (Forward looking approach)
Beta	[2]	0,68	0,68	0,52	Beta
Market Risk Premiun	[3]	4,70%	2,80%	4,70%	DMS MRP (Home Bias or International)
Nominal after-tax cost of Equity	[4]	5,59%	4,29%	4,82%	1+ (2 X3)
Risk Free Rate (CoD)	[5]				
Debt Premium	[6]	2,81%	2,81%	2,81%	Mid-point between both approaches
Pre tax Cost of Debt	[7]	2,81%	2,81%	2,81%	5+6
TAX RATE	[8]	25%	25%	25%	
D/(E+D)	[9]	0,50	0,50	0,50	
D/E	[10]	1	1	1	
Nominal Post Tax WACC	[11]	3,85%	3,20%	3,46%	([4]x ([1]-[9]) + ([7]x [(1-[8]) x[9])
Pre tax allowed rate of return	[12]	**5,13%**	**4,27%**	**4,62%**	[11]/(1-[8])
Base Rate boe	[13]	1,79%	1,79%	1,79%	10 year spanish bond (24 months)
Spread bps	[14]	335	248	283	[12]-[13]

* Using the forward looking RFR and the rest of the parameters from the main scenario

Results

As it can be noted, from all the possible alternatives the conclusive outcome (5.86%) is found in the upper region of the ranges; therefore – based on the assumptions previously described – utilities will be sufficiently remunerated, although other criteria (e.g. pure utilities, 3-year period of study, 1-year period of study, home bias) might argue setting a lower allowed rate of return. However, the conclusive outcome is in line with the fact that the costs of underinvestment are higher in the long term that the costs of overinvestment.

Finally, the conclusive outcome is in line with the mandates of the current regulation since the proposed retribution is consistent to a low risk activity and the cyclical situation of the Spanish economy. Additionally, the proposed allowed rate of return is equivalent to efficient and well-managed electricity utilities in Spain and the European Union, having its basis on a peer group of European utilities. A summary of the results is presented in

Table 70.

Table 70 Conclusive outcomes derived from the analyses performed (T&D)

	Alternatives			Outcome
Period of Study	3-year	vs	6-year	6 years
Bonds	4,17%		5,76%	5,76%
IRS + CDS	4,47%		5,95%	5,95%
Cost of Debt	Bonds	vs	IRS + CDS	Mid-point
	5,76%		5,95%	5,86%
Type of Utilities	Pure	vs	All	All
	5,21%		5,86%	5,86%
Investor	International	vs	Home Bias	International
	5,86%		4,99%	5,86%
Risk free rate	Historical (6Y)	vs	Forward Looking	Historical (6Y)
	5,86%		5,13%	5,86%

6.2. Discussion of results

So far this work has provided results for two important sectors of the electric power industry in Spain. These results can be compared to the current values in the regulation. This work is not expected to obtain the same results than the current ones because the economic conditions now are different from the moment when the current rates were set (Year 2013). In addition to this, the rates of return had been set without a clear methodology and just as a spread on top of the state bonds yields. The methodology proposed in this work based on the WACC can be replicated at any moment and should reflect the economic and financial conditions during the period of study (the 6 years historical period – equivalent to the length of the regulatory period – has been considered as a conclusive outcome of this work).

Table 71. Conclusive results

	Current [3]	Proposal [4]	[3] - [4[]
RES generation [1]	7,50%	6,83%	0,67%
T&D and Isolated energy systems [2]	6,50%	5,86%	0,64%
[1] - [2]	1,00%	0,98%	

Table 71 presents the results of this thesis work and the current rates stablished in the regulation. The spread between the RES generation and the T&D activities is currently 100 bps and this difference persists (98 bps) for the proposed values. The main reason behind the difference between these two rates is the nature of the industries involved. While the network industries are considered as low risk businesses, the RES generation has slight market exposure and additional risks to bear in mind. This difference in the rate of return of the two activities can also be inferred from the CEER Report on Investment Conditions in European Countries (2016) and the DiaCore Report (2016). These reports provide WACC based return rates for T&D activities and Renewable energy projects respectively. The average spread between the network activities and the renewable energy projects rate is 4.18% (418bps). It must be said that DiaCore´s results are based on market values from 2013 when the interest rates were higher than the rates in 2016 when the CEER Report was updated. Annex 2 presents the results from this analysis for the countries were public information was available.

Regarding the difference of the current rate and the proposed one within the same industry, there has been a decrease in the rates consequence of a different economic environment at the setting moment. For example, in 2013 the average of the state bonds used to set the allowed rate of return was 3.5% and at the present moment this rate is 1.79%. As a result, investors should not expect the same remuneration rate as it was 6 years ago. The decrease of the rates in both cases is around 65 bps.

Chapter 7

7.Conclusions and Future Work

7.1. Conclusions

This work has contributed with a new methodology for the calculation of the rate of return for Renewable energy generation in Spain. This duty is by no means easy if it is taken into account that the rest of European countries do not use explicit rates of return to remunerate renewables. Getting the appropriate benchmarking was rather difficult and the selected cases do not correspond exactly to regulated rates of return. In spite of the previous considerations, the benchmarking conducted contributed to get insights on some elements related to the renewable energy sector and in some cases to the WACC methodology itself. The main developments were related to the liquidity test and the addition of a risk spread to the traditional WACC/CAPM model.

The Spanish regulatory framework was also an important tool for the development of this work. Directives regarding the considerations to take into account constrained certain decisions regarding the proposed methodology. For example the additional risks added to RES came from the price bands adjustment and the penalties to delays in construction established in Royal Decree 413/2014 and other laws regarding the rules of the auctions for renewables. In the same way, the regulatory framework was the most important factor towards the decision of using the same rate of return for T&D and generation in the isolated energy systems. The Spanish regulation provides similar remuneration schemes to both industries and classifies them both as low risk businesses.

Another important element in the regulatory framework is the fact that the allowed rate of return set at the beginning of the next regulatory period is intended to last unchangeable for the whole regulatory period (6 years); although this could be justified in order to keep a low regulatory risk level (predictability on the rate of return), it is a challenging task to predict the economic conditions for the next 6 years in advance. This design feature was taken into account when comparing the proposed rate of return with the rate of return proposed by the regulator in the airport sector and when selecting the 6 years period of study. The use of spot values could be reasonable in case of frequent updates of the rate of return, but in the case of the regulated electric power industry the established regulatory period is six years with no possible review of the rate of return in between.

Although it is out of the scope of this thesis work to modify the current regulatory framework, after the development of this work some recommendations are presented towards possible improvements. In first place the remuneration rate for RES should be different according to each technology. This is something that is evident in the market, some mature technologies should have lower rates than more experimental or new technologies that still require research and development to reach maturity.

It is not the same an on-shore wind farm as an off-shore. The risks of the latter technology are higher because its research stage is earlier. In the same way, every technology has its own risk and should be assessed differently. This is not technology discrimination, but quite the opposite, a way to make all the technologies compete under the same conditions.

Another element that could be implemented is the use of different rates according to the development stage of the projects. There are at least two different stages in the development of a project: construction and operation. The risks in both stages are different and should be considered. As suggested in the British case the construction stage accounts mostly for technical and management risk, whereas the operation stage accounts for market design risk and price risk.

Concerning the conclusive results obtained it is interesting to see how both rates of return have similar behavior and provide lower figures than the current regulatory rates. The spread between T&D and RES continues to be approximately 100bps and the rates have decreased approximately 65bps with respect to the rates set in 2013 for the current regulatory period. Therefore, it might be concluded that, according to the data and the methodology proposed by this research, Spanish companies are slightly over-remunerated (0.65 %), in comparison to the proposed figures, for the remaining years of the current regulatory period (2 years). Nevertheless, this regulatory decision cannot be judged straightforwardly based only on these figures; it is also important to understand and analyze, as previously said, the investment necessities in Spain in 2013, and the economic and industry context that prevailed at that time.

7.2. Future work

This methodology has taken a big step regarding the calculation of the rate of return for RES and the isolated energy systems in Spain. Even though some methodological aspects could not be performed in this work because of lack of time and availability of reliable information but should be taken into account when setting the rates in 2019.

In first place, for the assessment of the parameters and risks, surveys to the stakeholders should be carried out. This is done both in the NERA (2016) report for the British government and in the DiaCore (2016). Surveys allow to get insights on the perception of stakeholders. These surveys would provide better understanding of funding sources, additional risks and the investors' perspective. It was evident during the development of this work that there is a lack of market data that allow to get a correct assessment of risks of the RES companies. In some cases, like the cost of debt used for pure RES companies or the additional risks, some approximations had to be done because of this. The main drawback of surveys is the trend by stakeholders to overestimate the risks in order to increase the rates of return. In order to control for this overestimation, the surveys could be performed on the T&D activities as well. Having additional information from the stakeholders should drive to more accurate figures when cross-checking results. The survey results would only be a complement to the WACC model and in no case a replacement of it.

Next, it would be valuable to perform cash flow modelling of the RES projects in order to assess the specific risks entailed. A correct modelling of energy prices, price hedging and scenarios for the development of the projects would lead to accurate spreads and better understanding of the risks involved in RES generation. It has to be considered that there are more than 1.400 different types of renewable installations according to the regulation, so this modelling should be done over average installations that represent the majority of the plants operating in Spain.

Finally, regarding the smart grids remuneration a deep technical and economical work should be conducted to provide guides and meaningful suggestions towards a remuneration scheme. As it has been mentioned, not much is written in the current regulatory framework so there is plenty of room for recommendations and improvements. What is clear is that innovation must be encouraged if the country actually commits to reach the climate change commitments for 2030 and 2050.

Annex 1

List of peer companies used in the DiaCore (2016) report.

Name	Country	Comments
Verbund Ag Inh. A	Austria	Included
E4u A.S. (Sep:Eforu)	Czech Republic	Country Not Included
Greentech Energy Systems A/S	Denmark	Included
Vestas Wind Syst. Nam.Dk1	Denmark	No Res Generator
Theolia (Futurem)	France	Included
Eneovia Société Anonyme	France	No Relevant Market Data
Roth + Rau O.N.	Germany	No Res Generator
Aleo Solar Na O.N.	Germany	No Res Generator
Capital Stage Ag	Germany	Included
Colexon Energy (7c Solarparken)	Germany	Included
Conergy Ag O.N.	Germany	No Res Generator
Daldrup+Soehne Ag	Germany	No Res Generator
Energiekontor O.N.	Germany	Included
Ktg Energie Ag	Germany	No Res Generator
Manz Ag	Germany	No Res Generator
Nordex Se O.N (Acciona)	Germany	Included
Phoenix Solar Ag O.N	Germany	No Res Generator
Pne Wind Ag	Germany	Included
Sag Solarstrom Ag	Germany	No Res Generator
Sfc Energy Ag	Germany	No Res Generator
Sma Solar Technol.Ag	Germany	No Res Generator
Solar-Fabrik Ag O.N.	Germany	No Res Generator
Solarhybrid Ag Inh.O.N.	Germany	No Relevant Market Data
Solarworld Ag O.N.	Germany	No Res Generator
Sonne + Wind Bet.Na O.N.	Germany	Included
Sunline O.N.	Germany	No Res Generator
Sunways Ag O.N.	Germany	Mostly Operation In China
Umweltbank Ag O.N.	Germany	No Res Generator
Terna Energy S.A	Greece	Country Not Included
Alerion	Italy	Included
Enel Green Power Eo	Italy	Included
Enertronica	Italy	No Res Generator
Ergycapital Spa	Italy	Included
Falck Renewables S.P.A.	Italy	Included
Kinexia Spa	Italy	No Res Generator
Kr Energy Spa	Italy	No Res Generator
Ternienergia	Italy	Included
Electrawinds Se	Luxembourg	Country Not Included
New Sources Energy	Netherlands	No Relevant Market Data
Photon Energy N.V	Netherlands	No Res Generator
Edp Renovaveis Eo 5	Portugal	Included
Fersa Energias Renovables	Spain	Included
Gamesa Corp.Tec.I.Eo-, 17	Spain	No Res Generator
Iberdrola Sa	Spain	Included
Solaria Energia Y M.Eo-01	Spain	Included
Arise	Sweden	Included
Eolus Vind Ab	Sweden	No Relevant Market Data
Renewable Energy Generation Ltd.	Uk	No Res Generator
Infinis Energy Plc	Uk	No Relevant Market Data
Good Energy Group Plc	Uk	Included
Renewable Energy Plc	Uk	Included
Pv Crystalox Solar Ls	Uk-Ger-Jpn	Country Not Included

Annex 1

Liquidity Check for RES companies in detail.

Company	Bid-Ask Spread %	Liquidity (threshold= 1%)	Pure RES
IBERDROLA SA	0,03%	Yes	No
E.ON SE	0,03%	Yes	No
EDP-ENERGIAS DE PORTUGAL SA	0,05%	Yes	No
ENDESA SA	0,05%	Yes	No
ENEL SPA	0,06%	Yes	No
GAS NATURAL SDG SA	0,06%	Yes	No
EDF	0,06%	Yes	No
DONG ENERGY A/S	0,07%	Yes	No
SSE PLC	0,08%	Yes	No
FORTUM OYJ	0,08%	Yes	No
ACCIONA SA	0,08%	Yes	No
INNOGY SE	0,08%	Yes	No
ATLANTICA YIELD PLC	0,09%	Yes	Yes
DRAX GROUP PLC	0,10%	Yes	Yes
EDP RENOVAVEIS SA	0,11%	Yes	Yes
A2A SPA	0,12%	Yes	No
SAETA YIELD SA	0,14%	Yes	Yes
RENEWABLES INFRASTRUCTURE G	0,14%	Yes	Yes
VERBUND AG	0,14%	Yes	No
ERG SPA	0,18%	Yes	No
ACEA SPA	0,25%	Yes	No
ALBIOMA SA	0,27%	Yes	Yes
CAPITAL STAGE AG	0,28%	Yes	Yes
GREENCOAT UK WIND PLC	0,30%	Yes	Yes
DIRECT ENERGIE	0,31%	Yes	No
PNE WIND AG-REG	0,41%	Yes	No
FALCK RENEWABLES SPA	0,41%	Yes	Yes
ALERION CLEANPOWER	0,48%	Yes	Yes
MVV ENERGIE AG	0,67%	Yes	No
JOHN LAING ENVIRONMENTAL ASS	0,70%	Yes	No
ENERGIEKONTOR AG	0,73%	Yes	Yes
EOLUS VIND AB-B SHS	0,78%	Yes	Yes
BLUEFIELD SOLAR INCOME FUND	0,83%	Yes	Yes
NEXTENERGY SOLAR FUND LTD	0,85%	Yes	Yes
SOLARIA ENERGIA Y MEDIO AMBI	0,89%	Yes	No
7C SOLARPARKEN AG	0,99%	Yes	Yes
TERNIENERGIA SPA	1,05%	No	Yes
FUTUREN SA	1,27%	No	Yes
FERSA ENERGIAS RENOVABLES SA	1,29%	No	Yes
ARISE AB	1,30%	No	No
GREENTECH ENERGY SYSTEMS	1,65%	No	Yes
K.R. ENERGY SPA	1,74%	No	Yes
GALA SPA	1,87%	No	No
FRENDY ENERGY SPA	1,95%	No	Yes
INIZIATIVE BRESCIANE-INBRE S	2,08%	No	Yes
ERGYCAPITAL SPA	2,15%	No	Yes
GOOD ENERGY GROUP PLC	2,42%	No	Yes
NBW ENERGIE BADEN-WUERTTEM	3,13%	No	No
AGA IM Equity	3,52%	No	Yes
ENERGY LAB SPA	3,75%	No	No
GRUPPO GREEN POWER SPA	3,88%	No	Yes

Annex 1

Liquidity Check for T&D companies in detail.

Company	Bid-Ask Spread %	Liquidity (threshold= 1%)	Pure T&D
E.ON SE	0,03%	Yes	No
Iberdrola SA	0,03%	Yes	No
Engie SA	0,04%	Yes	No
Enagas SA	0,05%	Yes	Yes
EDP - Energias de Portugal SA	0,05%	Yes	No
Endesa SA	0,05%	Yes	No
Red Electrica Corp SA	0,05%	Yes	Yes
NATIONAL GRID PL	0,05%	Yes	Yes
ENEL SPA	0,06%	Yes	No
RWE AG	0,06%	Yes	No
Gas Natural SDG SA	0,06%	Yes	No
EDF - Electricite de France SA	0,06%	Yes	No
TERNA SPA	0,06%	Yes	Yes
SNAM SPA	0,07%	Yes	Yes
SSE PLC	0,08%	Yes	No
A2A SpA	0,12%	Yes	No
ELIA	0,12%	Yes	Yes
REN-REDE ENERGET	0,14%	Yes	Yes
VERBUND AG	0,14%	Yes	No
HERA SPA	0,17%	Yes	No
IREN SPA	0,21%	Yes	No
EVN AG	0,24%	Yes	No
ACEA SPA	0,25%	Yes	No
ASCOPIAVE SPA	0,28%	Yes	No
FLUXYS BELGIUM	0,96%	Yes	Yes
LECHWERKE AG	0,99%	Yes	No
ACSM - AGAM SPA	1,15%	No	No
HAFSLUND ASA SHS	1,63%	No	No
GAS PLUS	1,93%	No	No
ELVERKET VALLENTUNA AB	5,23%	No	No

Annex 2

WACC for T&D Activities (CEER, 2016) and implicit WACC for Renewables (DiaCore, 2016)

	CEER (2016)		DIACORE (2016)	
	Pre-tax WACC	Post -tax WACC [1]	Post-tax WACC [2]	[2] - [1]
Finland	3,86%	3,1%	6,70%	3,62%
Hungary	6,23%	5,7%	11,30%	5,63%
Italy	7,50%	5,7%	9%	3,30%
Poland	6,24%	5,3%	9,35%	4,05%
Sweden	6,50%	5,1%	8,20%	3,13%
The Netherlands	3,60%	3,1%	6,50%	3,44%
Spain	6,50%	4,9%	10,00%	5,13%
Greece	8,50%	6,9%	12,00%	5,12%
Average				4,18%

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