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Increased Transparency in Valuation

Extending the DCF Model with Monte Carlo Simulation

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Executive Summary

The objective of this study has been to include Monte Carlo simulation into the discounted cash flow (DCF) model and investigate the effect on risk transparency in the valuation result.

When valuing investment projects using the DCF method to estimate a net present value and the Capital Asset Pricing Model in order to estimate the systematic risk, the inclusion of financial risks is of great significance. The traditional the DCF model is set up based on most likely values presented as single point estimates, and can potentially hide valuable information since many input estimates in reality can undertake a broad spectrum of values. Further, only including risk in an adjusted discount rate or in overly conservative input estimates, results in a final valuation output that conceals information to the decision maker. To assess this problem and increase the level of transparency in project valuation when using the DCF model, this thesis evaluates how Monte Carlo Simulations can increase the level of information if included in the DCF model. The thesis is built around two similar investment projects in the form of a case study. The case projects, provided by DONG Energy A/S, were valued based on both the traditional DCF approach with point estimates and the simulation based approach where the point estimates are replaced by probability distributions. Under this research method the two valuation approaches are compared based on the cases and found various potential benefits by including Monte Carlo simulations in the DCF model.

The main finding was that the simulation based valuation approach is potentially enables the valuation to be better aligned with the CAPM theory and the division of risk into systematic and non-systematic, as the need to adjust the discount rate decreases. Further, this methodology provides a clearer picture of the project risk profile and stimulates an improved input estimation procedure with improved discussions between personnel involved in the valuation process, compared to the DCF model with static inputs. Lastly the simulation approach provides usable information when comparing different investment opportunities.

The result in this thesis has not previously been found in the academic literature, and thus adds a new perspective to the existing ongoing discussion concerning the risk assessment in capital budgeting. Based on the findings in the study and we feel confident in recommending the usage of the Monte Carlo method to managers, who wish to increase the level of information in the DCF valuation and better reveal and assess the risk profile of potential investments.

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Clarification

In order to avoid confusion, it should be noted by the reader that the numbers used in this text are formatted using comma (,) as thousand separator and period (.) as decimal separator.

1. Introduction

This introductory chapter will provide the background to the subject studied and a discussion of the underlying problem that will be dealt with in the thesis. Based on the background and the problem discussion, the specific research question will be defined, followed by a review of previous research undertaken in relation to the subject.

1.1. Background

The goal of growth and profitability is essential for all companies. In order to accomplish these goals, companies continuously seek profitable investment alternatives that must be accurately valued. One of the most used valuation method for estimating and analyzing the attractiveness of investment opportunities is the Discounted Cash flow (DCF) model and techniques based on this model (Graham & Harvey, 2001; Bruner, 2007; Correia, 2012). The DCF framework is used within capital budgeting as well as for estimating the enterprise value of entire firms based on forecasted income statements and estimated free cash flows (Petersen & Plenborg, 2012; Koller, et al., 2010). Essentially, the DCF method is based on estimates of estimated future expenditures and revenue, and the resulting forecasted cash flows are afterwards discounted using an appropriate discount rate in order to account for the time value of money, and to estimate a present value of the cash flow stream. A frequently used discount rate is the weighted average cost of capital (WACC), which is the weighted average of the required return by various investors (Koller, et al., 2010). The return required by investors is depending on the overall risk of the investment, where risky investments in general are subject to higher required return by capital providers. The risk referred to could be estimated with various asset-pricing models, among which the most used method for estimating the required return to equity investors is the capital asset pricing model (CAPM) (Graham & Harvey, 2001; Brounen, et al., 2004; Meier & Tarhan, 2007).

The CAPM is based on portfolio theory where the total risk is divided into *systematic non-diversifiable risk* stemming from the market and *diversifiable risk* that is specific to the single investment project or company. This separation of the different types of risk is based on an investor's perspective and the assumption that investors can diversify among assets. The resulting effect of the diversification is that investors only receive a premium for taking on the systematic risk since the non-systematic risk is assumed to be possible to diversify away in a well-diversified portfolio according to CAPM (Sharpe, 1964). The implication of the theory for project valuations using the DCF is consequently that only the systematic risk should be accounted for in the discount rate since the investors only should get paid for exposure to this kind of risk (Brealey, et al., 2011).

1.2. Problem discussion

Since project valuation conducted using the DCF framework introduced above is based on forecasts and estimates of the future cash flows, the estimated present value is subjected to embedded uncertainty, referring to the non-systematic risk also described above. This since the forecasted cash flow estimates essentially are based on more or less qualified assumptions regarding both the future potential revenues as well as expenditures. As a result, there is to a varying extent inherent uncertainty in those estimates since these values can be considered best guesses of a range of possible and uncertain outcomes (Hertz, 1964; French & Gabrielli, 2004; Clark, et al., 2010; Nowak & Hnilica, 2012). Naturally, when conducting the DCF valuation process the appraisal of this kind uncertainty and risk is a critical task in order to make informed decisions based on the valuation results. As a result, different methodologies exists that all seek to deal with non-systematic risk and uncertainties within the DCF framework. Based on previous research and the logic of the DCF framework, there are two possible approaches to account for the inherent financial risk and uncertainty.

The first approach is to increase the discount rate and by this decreasing the calculated NPV. The implication of this is that the investor thereby requires a higher price for taking on a higher level of risk. Nonetheless, according to the CAPM theory, one must keep in mind that the discount rate only should be adjusted for compensating the investor for systematic risk attributable to the project. To increase the discount rate in order to also account for project specific non-systematic risk is not recommended even though this approach to uncertainty is used on real life by adding so called "fudge factors" to the discount rate and by this manually manipulating it (Brealey, et al., 2011).

The second alternative is instead to adjust the model input estimates and thereby indirectly adjust the cash flow estimates in order to include non-systematic risk. By weighting-in the probability of outcomes other than the most likely value, an *unbiased* input estimate and consequently an unbiased cash flow estimate is obtained (Brealey, et al., 2011). For example, in practice this would mean that if the person estimating the input variables is uncertain about a cost estimate, it is possible to account for the risk and thereby lower the cash flows and in turn the estimated value. Independently of the choice of method, the result is an adjusted and, in many cases lower projected value. However, both approaches for dealing with non-systematic risk are subjected to limitations since risk and uncertainty potentially could be concealed in either the cash flow estimates, or in the discount rate if it is adjusted for risk not solely classified as systematic.

Moreover, if considering two similar investment projects, these can even be attributable to more or less the same systematic risk imposed from the overall market, but still be subject to different degrees of uncertainty in the cash flow estimates. For example, the cash flow estimates of two potential investment projects may be equal even though the underlying uncertainty might be different. In this kind of situations it might be difficult to separate and reveal the underlying difference in risk and uncertainty exposure between two mutual exclusive projects with the above explained techniques. In practice firms apply both the previous described approaches (adjust the discount rate or the cash flows) to handle the problem with cash flow risk (Graham & Harvey, 2001; Ryan & Ryan, 2002; Meier & Tarhan, 2007; Brealey, et al., 2011).

As a result of the problem with information and uncertainty that is potentially hidden in the estimated values, companies often performs *sensitivity* and *scenario analysis* (Ryan & Ryan, 2002). By using sensitivity analysis the aim is to assess which effects a change in critical inputs will have on the cash flows and the project value respectively. Scenario analysis on the other hand, is performed to value the project under specific unique circumstances (Brealey, et al., 2011). The goal with both types of analysis is to reveal what the underlying uncertainty could imply for the project value if the estimated values turn out to be different than expected.

The problem is however that when conducting these approaches neither evaluates situations that could be considered realistic. The sensitivity analysis only reflects the effect of the risk attributable to a single input variable at a time and scenario analysis evaluates different possible scenarios but does not necessarily considers the probabilities of the occurrence of these scenarios. Further, both methods do not consider the effects of the input variables being interrelated and consequently assume that variable values can vary independently.

A more sophisticated method used to evaluate the risk and uncertainties inherent in the cash flow forecast is to extend the DCF model with the use of *Monte Carlo simulation*. With this method, input variables are estimated as probability distributions rather than static values. The Monte Carlo process includes running a large number of simulations, yielding a whole set of possible project values. This range of project values can then be analyzed and categorized according the probability of them occurring based on the occurrence frequency revealed by the simulation process. In turn, this process results in a final valuation output estimated as a complete probability distribution, compared to the single static values estimated with the standard *deterministic* DCF model. Naturally, adopting the Monte Carlo method is therefore a potential effective tool to reveal more about the crucial underlying uncertainty that otherwise is embedded and potentially hidden in the estimated point values, the biased cash flows or not even taken into account. To sum up, the problem with the traditional DCF framework when applied to project valuation, is that it lacks *transparency* regarding the inherent uncertainty in the estimated input values and consequently the resulting discounted present value used by decision makers.

1.3. Purpose and Research Question

Based on the preceding problem discussion the purpose of this thesis is to evaluate how including Monte Carlos simulation analysis in project valuation can increase the level of transparency and information from a financial risk perspective. Especially, the study will compare how the standard deterministic DCF model using static values behaves compared to a simulation-based approach when projects facing different levels of non-systematic risk and uncertainty are assessed. In addition, the study will also discuss how the different approaches relate to CAPM and the distinction between systematic and project specific risk.

The specific research question that this study seek to answer is as follows:

"How is the transparency in project valuation using the DCF model affected if the project specific risk is simulated, rather than embedded in static valuation model input estimates?"

1.4. Delimitations

Several delimitations and assumptions have been necessary to undertake in order to define the boundaries of the study. As in all research it is critical to narrow down the collection of information with the intention of making the final analysis manageable and distinct in relation to the research question. Therefore emphasis has mainly been made on those factors that impose the greatest impact and relevance relative to the research question.

Since the aim of the research question is to investigate how the transparency in project valuation is affected depending on how project specific risks are defined and included into the DCF framework, only information and theories affecting this subject will be considered. Consequently, the DCF valuation framework, including CAPM and Monte Carlo simulation will constitute the definite boundary for the research in a broader sense, and other valuation models will not be taken into consideration. In addition, strategic approaches such as real options, decision trees or related themes surrounding a strategic perspective of valuation will not be considered. However, a brief presentation of these approaches is found in the section of previous research below in order to inform the reader of the main ideas of these methods often discussed approaches to risk and uncertainty in project valuation.

Considering delimitations regarding the quantitative case specific data, such as production data for wind farms or various costs estimates, primarily data provided by experts at DONG Energy have been used. The choice of only gathering wind farm specific cost data from one source was taken since the aim has been to investigate the valuation methodologies rather than an exact and generalizable value of the cost inputs associated with wind park investments. If the aim were to estimate a general value of a wind park investment, market based data from various sources would have been appropriate to use. It is however important to note that the input estimates are realistic and based on authentic market values. Furthermore, in order to assess the effects on transparency and the risk incurred by the different valuation approaches, this detail will not affect the result of the discussion.

Lastly, the valuation and the concluding discussion will exclusively be applied to a case study, which concerns the valuation of two offshore wind park project on different sites in Denmark.

1.5. Previous Research

The desire to account for, and assess the level of risk is a common issue in project valuation and various academics suggests different theories and approaches. Although previous research is comprehensive regarding the issue of how risk and uncertainty is handled within capital budgeting, the choice has been made to focus on presenting the latest research related to uncertainty and risk inclusion within the DCF-model, or as an extension of this model.

1.5.1. Alternatives Approaches to Include Uncertainty in the DCF Framework

There are several methods for extending the DCF model to take into account risk and uncertainties. These below described approaches can however be referred to be of a more strategic than financial character.

Decision Tree Analysis

One method that aims to include the value of uncertainty is the decision tree analysis. By this approach, the problem with uncertainty and decision making is structured by mapping out sequential alternative management actions that could be undertaken as reactions to environmental or market changes during the life span of a project. The map known as the tree consists of nodes where each node is subject to an alternative approach that is given a probability in the valuation. The model aims to calculate a net present value but the most likely discounted NPV is estimated by multiplying the NPV for each decision tree branch with a probability of each decision that can be made at the nodes. The total estimated project NPV is consequently estimated in a backward process as each node is multiplied by its specific probability, which thus is a way to model future uncertainty (Brealey, et al., 2011). Therefore, instead of modeling a single stream of cash flows, the constructed tree with all the probabilities generates a final estimated value, which is considered as a weighted average of the different paths.

The decision tree approach is valuable for mapping alternatives that may arise along with a project (Brealey, et al., 2011). However, it can be difficult to estimate an appropriate discount rate for the alternative branches and especially if one node contains the option to defer an investment decision (Koller, et al., 2010). Furthermore, when a real situation is complex, the more layers that are added to the tree, the more difficult it is to apply the method and the method is no longer practical to use under such circumstances (Baker & Pound, 1964). The decision tree approach has also been criticized since it is demanding to estimate the probabilities of the appropriate up and down at the nodes (Lander & Piches, 1998) and (Koller, et al., 2010) expresses the problem as it is not possible to estimate these probabilities based on market movements without using an options approach. The decision tree approach therefore also related to the real option approach where options are estimated for each decision node.

Real Options

The real option approach to uncertainty is related to the assessment of risk and uncertainty in capital budgeting that concerns the worth of not investing immediately, but instead tries to incorporate the value of strategic options into the valuation. The real option technique currently has a boom in terms of the number of articles published and is a recommended framework when the analyst wants to estimate a quantitative number of strategic decisions. Under this approach various option valuation techniques such as the Black and Sholes model, binominal trees and decision trees are used to estimate strategic decisions based on an underlying asset.

Among famous papers written about the real option approach are those written by Dixit & Pindryck (1995), Trigeorgis, (1993b) and Amram & Kulatilaka, (2000). A general goal of the real option technique is to include the value of managerial flexibility to the valuation. As a result the value of different options are added to the traditional DCF framework in order to include a second part in the valuation: the value of possible strategic options surrounding the investment decision (Copeland, 2001; Barnette, 2005). In this case the estimate based on the DCF model are used for the planned path, and the option value for the observed real options that exists alongside the planned path. The result is that the NPV estimated by the DCF is combined with a NPV of the future the real options. They intuition of the real option approach was illustrated by Trigeorgis (1993b) accordingly:

$$NPV_{Investment} = NPV_{DCF} + NPV_{Options}$$

Source: Trigeorgis (1993b)

The authors who advocate the real options approach argue that the real option model in general is better than the DCF-model (Dixit & Pindryck, 1995) and that the classic DCF-framework undervalues investments since it is not capable of capturing the value of options (Trigeorgis, 1995). On the other hand, the applicability of the option framework in practice has been criticized even though the concept is appealing in case where uncertainty has a great impact on the valuation (Borison, 2005).

These described approaches to treat uncertainty are as explained focused on what can be considered as strategic uncertainty or risk that also is subject to project valuation processes. Real options and decision trees are however not convenient for situations where the level of irreversibility, flexibility, information revelation and uncertainty is low (Krychowski & Quélin, 2010). In those situations, the DCF and NPV approach is more appropriate according to Adner & Levinthal (2004). Though, as this study takes place in the phase right before construction the uncertainty is low and no directly relevant real options exists after this phase. Consequently, this study will, as was also noted in the delimitations (section 1.4) not focus on this kind of methodologies. However, since those alternative approaches are also discussed in the literature related to the DCF method, this brief presentation of the main ideas was necessary. Nonetheless as this study will focus on the treatment of financial risk of investment valuations rather than strategic aspects, the rest of this section of previous research is devoted to present previous research associated with the DCF-model and the discussions related to how financial risk and uncertainty is handled using this method.

1.5.2. Financial Risk in the DCF model

There are several approaches to assess financial risk in the DCF model. One discussion in previous literature is the issue whether companies should estimate a project dependent cost of capital (PDCC) or simply use a firm-wide cost of capital for discounting the forecasted cash flows in the DCF model is commonly debated. Titman & Martin (2011) argue that there are several benefits of using a single firm-wide discount rate, primarily relating to simplifying the valuation process. This is confirmed in practice by for example Graham & Harvey (2001) who surveyed Fortune 500 companies and found that 58.8 % of the included firms did always or almost always not risk-adjust the discount rate to reflect the market exposure for a certain project. Further, if the company uses a risk-adjusted discount rate to various projects, a related issue concerns how companies account for non-market related risk in the DCF valuation. As presented in the introduction of this thesis, two common approaches to this problem found in previous research is to adjust the discount rate for project specific non-systematic risks or to adjust the cash flows through the value drivers to account for these uncertainties. Gitman &

Vandenberg (2000) for example found that 39 % of the firms adjusted their discount rate in favor of adjusting their cash flows while 21 % did both. The same result was confirmed by Chan, et al. (2008) who found that some companies adjusted the cash flows to account for uncertain input (37 %), others adjusted the cost of capital instead (29.6 %) and some companies used both methods (33.3 %). In this discussion academics stress that discount rate should be changed in order to correspond the systematic risk imposed on a project according to CAPM (Brealey, et al., 2011; Krüger, et al., 2011). While the CAPM model is the single most used for estimating the risk adjusted cost of equity among large companies, a large fraction of these companies tend adjusts the CAPM results (Graham & Harvey, 2001; Chan, et al., 2008). A study conducted by Krüger, et al. (2011) confirmed that firms tend to bias investments upward for divisions with higher risk than the firm in general when they used the same WACC for all projects, a result that confirms the theory. Other studies can confirm that firms add a premium to the discount rate in order to include project specific risk (Meier & Tarhan, 2007; Brunzell, et al., 2013), which is referred to fudge factors (Brealey, et al., 2011), an approach that it not consistent with theory.

If the above discussion concerns how risk is included into the DCF model, related research pays attention to the evaluation or the analysis of the uncertainty and risk attributable to the valuation results. These approaches include sensitivity, scenario and simulation analysis, were the sensitivity and scenario analysis serve to see what happens to the project value if the estimated most likely values changes. In the survey of what Fortune 1000 firms did in practice Ryan & Ryan (2002) found that 20.5 % always used sensitivity analysis, 10.5 % scenario analysis and only 3.1 % always used simulation. The related study undertaken by Graham & Harvey (2001) found that 51.54 % of the companies used sensitivity analysis, 26.59 % and 13.66 % used simulations (See Appendix 13:13 for further details). These studies are often referred to and a more recent capital budgeting survey research covering such comprehensive data has not been found. However, with reference to the studies it seems as companies use the deterministic DCF model and that more sophisticated risk analysis methods such as the simulated approach is not very common when assessing the risk in capital budgeting.

Considering research that compares the deterministic DCF model with simulated approaches, previous research has pointed to limitations of the static approach when calculating the present value. The presence of uncertainty associated with main analysis parameters such as cash flow, cost and discount rate calls for a probabilistic extension of the traditional approach as uncertainty de facto exists in the underlying parameters (Flaig, 2005; Carmichael & Balatbat, 2008). Accordingly previous researchers have suggested a *simulation-based DCF* approach. Many previous related studies evaluate the application of a Monte Carlo simulation-based method when valuing real-estate projects, such as Nygard & Razaire (1999), French & Gabrielli (2004), French & Loizou (2012) and Meszek (2013) but also when valuing various exploration and production (E&P) projects (Ball & Savage, 1999; Komlosi, 2001). The use of Monte Carlo simulation as method is not new and has been an important component of quantitative economic risk analysis since David B. Hertz published an article in 1964. Hertz proclaimed that the difficulty in static capital budgeting lies in the assumptions and their impact on the result since each assumption involves its own degree or uncertainty. Hertz also argued that when taken together, several assumptions could multiply into a total critical uncertainty, which called for the simulation-based approach as an important improvement to get rid of the problem. However since the computer power and sophisticated software packages have developed a lot during the last decade, a series of new articles has surfaced. In these recent article the uncertainty and risk in valuation is discussed and the benefits of simulation-based DCF-models are highlighted in comparison to static models (Kelliher & Mahoney, 2000; French & Gabrielli, 2004; Clark, et al., 2010). For example, French & Gabrielli (2004) and Clark, et al. (2010) analyzed how uncertainty could be incorporated into the DCF-framework in their practical oriented articles. The researches apply the Monte Carlo simulation methodology and criticizes that uncertain valuations are reported as point estimates in the standard deterministic DCF model, without any information of the underlying uncertainty. Nowak & Hnilica (2012) who also investigated the benefits with simulations in a recent published article, argues that the distribution of a specific input variable should not be understood as a probability distribution, but more as a distribution of uncertainty regarding the model output. However, by replacing the static numbers with distributions allows, according to them, for a wide range of improvements of the financial modeling, and to represent uncertainty by distribution is a powerful method for capturing possible outcomes and scenarios.

To sum up what previous research shows concerning the DCF valuation model and financial risk, companies use different approaches to include risk and uncertainty in the DCF model. Some of the firms prefer to adjust the discount rate and others tend to adjust the cash flows in order to account for uncertainties. Furthermore, companies make use of different approaches to analyze the result of the valuation. The use of simulation based DCF is however not very widely used according to previous surveys, despite that the method is not new and despite that previous research has confirmed the superiority with simulations compared to static models.

1.6. Contribution

Several researchers such as French & Gabrielli (2004), Tamošiūnien & Petravičius (2006) and Clark, et al. (2010) have published articles dealing with the concept of incorporating Monte Carlo simulation in the DCF model as a method for assessing the level of risk attributed to a proposed investment opportunity. However the majority of these articles put emphasis on factors relating to performing the analysis based on this method. While it can be said that assessing risk by including the variability of the input variable estimates implicitly relates to the concept of including non-systematic risk in the DCF model, no previous research found relates this Monte Carlo simulation approach to the concepts associated with the discount rate and ultimately the CAPM.

Survey evidences from studies, for example those undertaken by Graham & Harvey (2001) Brunzell, et al. (2013) and Meier & Tarhan (2007) conclude that practitioners to a large extent use subjective methods to deal with project specific risks. Relating to this, primarily how Monte Carlo simulation incorporated in the DCF model when applied in capital budgeting potentially can increase the level of transparency in the valuation results by revealing project specific risk, instead of concealing this in the discount rate or the input estimates is discussed. Further, how this method for risk assessment relates to CAPM is evaluated.

To our knowledge no previously published studies have assessed the topic of how the simulation methodology appraises non-systematic risk related to financial theory, which therefore distinguishes our study from previous published research.

1.7. Outline

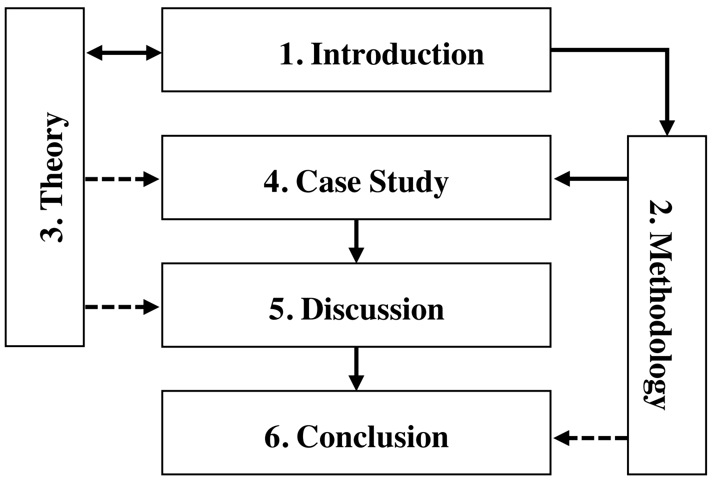
To help the reader getting an overview of the thesis the overall structure is illustrated in Figure 1 below. The thesis is structured in an academic sense where the first chapter (Introduction) have been an introduction to the research field and under which delimitations the thesis is written.

The second (Research Method) and the third chapter (Theory) are devoted to the research approach adapted in the study and a presentation of the relevant economic theories referred to.

In the fourth chapter (Case Study) the empirical capital budgeting case is presented followed by the actual valuation based on the deterministic DCF model as well as the simulation-based approach. The valuations aims to investigate the different valuation approaches in detail in order to see how they differ regarding the risk transparency. As mentioned, DONG Energy has provided the valuation cases concerning two potential offshore wind farms investments in Denmark, which are considered as mutually exclusive, e.g. that only the potentially most profitable project will be executed. DONG Energy has also recently introduced a simulation-based technique in their capital budgeting process, which makes it possible to get valuable empirical inputs to be used in the study.

The findings and the result from the case study are afterwards discussed and analyzed in chapter six (Discussions of Findings) based on the theoretical background and inputs from professionals who are currently involved in the capital budgeting process at DONG Energy. The final chapter (Conclusion) of the thesis contains the conclusion and a discussion of suggested approach to further research related to the topic.

Figure 1: Interrelationship between Thesis Sections



Source: Own construction

The structure of how the six thesis chapters are interrelated is also represented in Figure 1. The interpretation is that the first introductory chapter, features the problem discussion, which is derived from the shortcoming of certain established theories. This problem discussion and thesis purpose has led us to adopting the specific research methodology suitable for this study. Based on the chosen methodology a case study is performed, which in turn has its foundation in the mentioned theoretical concepts in order to assess these. The results from the case study is afterwards discussed in chapter five within the theoretical framework previously introduced. Lastly in chapter six, we conclude our findings, consistent with the chosen research methodology. In conclusion, the theory and research methodology chapters are the two backbones of this thesis, allowing us to go from the derived research question to reaching an answer to this question.

2. Research Method

In academic research it is important to have a critical attitude and evaluate the validity, reliability and generalizability of the research. This chapter aims to present the research approach and the research methodology adopted in this study. Furthermore this chapter provides a description of how the study relates to the scientific view and how knowledge is generated by the methodology, and also the limitations surrounding the research approach.

2.1. Scientific View

The knowledge generated in this study is, as most research, based on a phenomena observed in reality. From a research perspective, the phenomena observed could be characterized by an underlying paradigm that explains how the reality is perceived. The two most classic and basic paradigms are the *positivism* and the *constructivism* (Bryman & Bell, 2011). These paradigms are distinguished based upon their assumptions related to the philosophic terms; *ontology* and *epistemology*. The ontology could be defined as the nature of reality and thus assesses how the reality is considered and the epistemology refers to knowledge and the relation between the subject studied and the researcher. Further it is referred to as the nature and theory of knowledge and also concerns what knowledge is and how it is created (Anderson Hudson & Ozanne, 1989). To clarify, the paradigmatic assumptions are vital in the research since it enriches the understanding of the analysis and how the results are derived.

The central dogma of the positivistic paradigm is the objectivistic relation to reality, which implies that an objective reality exists independently of consciousness, and that it is possible to abstract a level objective knowledge from perception and an inductive logic (Bryman & Bell, 2011). Based on the positivistic attitude to knowledge, valid scientific knowledge is then exclusive derived from logical and mathematical processing of empirical data and subjective and intuitive values are rejected (Bryman & Bell, 2011). That is, the positivistic attitude seeks general laws applicable to many different situations, which consequently aligns the positivistic viewpoint with the objective ontological sense. This attitude is also the basis for many theoretical financial models that can be verified mathematically by empirical studies.

In contrast, the constructivist as the opposite epistemological perspective believes that there is no objective reality but rather that social phenomena and the significance of those are continuously created through interaction of various social actors. Hence, new knowledge is continuously constructed as new information is interpreted together with already existing knowledge in a continuing process where patterns are identified (Anderson Hudson & Ozanne, 1989). This perspective implies that it is possible to construct generalizable results and knowledge derived from specific examples, for example a case study. Further the reality is considered as relative and multiple. As a result there can be more than one reality created through subjective interpretations and believes about a specific subject in matter (Anderson Hudson & Ozanne, 1989; Carson, et al., 2001).

However, since we neither believe in a strictly objective reality, the constructivist viewpoint is regarded as the most satisfactory for this study. Naturally it also follows that the researchers will have an impact on the outcome of the study since concepts and conclusions are constructed by the researchers and for example by participants of the study who seeks to explain their experiences (Corbin & Strauss, 2008). Furthermore, when the research neither is driven by hypothesis testing nor intended to test and verify an established theory, but instead focused on drawing inferences based on time and context bound data, it is considered as appropriate to use the constructivist viewpoint according to Bryman & Bell (2011). The choice of the constructivism as a scientific body is similarly motivated since we will perform a case study and since the data used almost exclusively is based on secondary sources and existing theories. The choice of paradigm is also confirmed by Stake (1995) and Yin (2003) when they seek to describe the case study methodology. Consequently, is it important to stress that this kind of data has been processed by subjective individuals and thus cannot be considered as an objective truth. Especially since input data from experts at DONG Energy will used, it must be stressed that this data is subjectively affected.

2.2. Research Approach

In order to seek answers to the research question the researcher must choose an adequate research approach. In general research adhere to either a qualitative or a quantitative method. The quantitative approach is often used when the research is characterized by a positivistic paradigm and the objective stance to knowledge, as discussed above. Consequently, the quantitative approach is often *deductive* which implies that the aim of the research is to develop generalizable theories or to revise existing theories based upon new data that is tested through hypothesis that are either rejected or confirmed. The qualitative approach on the other hand is often characterized by an *inductive* process were the research attempts to develop the theory through empirical observations (Bryman & Bell, 2011).

With respect to the constructivist's standpoint and to the nature of the research question the qualitative approach is applied in this study since the intention is to acquire novel insight and understanding about existing theories.

2.2.1. Abduction

However, despite the qualitative and nature of our research approach, our study will contain segments that are characterized by deduction. This, as we use the logic and assumptions of generally accepted models and statements, and apply these to data gathered within our case. Still, the aim is not to make any broad statistical inference based on our results or to test hypothesis based on our data, which is often the essence of the quantitative method and the strict deductive approach. Rather we will use, but not confirm or test, theories that once developed were established by quantitative methods. This implies that we assume the robustness of all theories used within the thesis and consequently they will not be challenged in that sense, even though we will motivate and discuss our choice of models and their implications for the results of the study.

Nevertheless, in order to strictly apply a qualitative approach characterized by induction described above the researches has to enter a field never studied before, which allows a theory to emerge from observed data. This situation defines the one extreme in a continuum between induction and deduction (Bryman & Bell, 2011). The other extreme, deduction, implies that hypothesis are set up and tested on the sample data according to the discussion above, since the deductive approach is based on existing theories that is confirmed or revised by new evidence and data. Due to these extreme circumstances it is common that the researcher undertakes an approach that is best described as a continuous interplay between both deduction and induction. This approach has been followed within this study, as the aim is not to develop a new theory whereby we do not stick entirely to the inductive approach. Nor do we follow the deductive approach where a logical and specific conclusion is reached based on testing of wide general statements, an approach that would have completely conflicted with our constructivistic scientific view.

Instead we have considered a third method for reasoning; the *abuctive* approach as most relevant for this study. This since we both make use of existing generalizable theories but also analyze case specific data. Bryman & Bell (2011) also supports this middle way, where quantitative research based on secondary data not necessarily have to be entirely either inductive or deductive. The abductive reasoning is characterized by an incomplete set of observations from which the most likely possible explanation is derived. In addition the abductive process encourage the researcher to move between a theoretical base and empirical findings (Alvesson & Kaj, 2007).

We believe that the abductive approach is the most suitable research approach in our case since we will make use of existing theories but also aim to compare the differences between methods applied to the DCF framework through the use of empirical data.

2.2.2. Case Study

In order to investigate the specific research question a single case study will be undertaken that is qualitative but with the inclusion of numerical parts since a project valuation is performed. The case study approach for knowledge generation was chosen since it is considered the most relevant and ideal approach for the purpose of an in-depth investigation of differences in a specific situation (Feagin, et al., 1991; Tellis, 1997). Further, the case methodology is relevant when conducting research on a single situation were the research is aimed at developing insights and knowledge about details (Baxter & Jack, 2008; Flyvbjerg, 1988). In addition, the case study is often based on the insight that universal theories of the society do not exist and that contextualized knowledge is more valuable (Flyvbjerg, 1988). This perspective thus is in line with the constructivist view discussed above. Further, the decision to perform a single case study was taken since it allows us to gain deeper understanding of the subject than would have been possible if several cases were studied. This since it allows us to make one thorough investigation rather than several superficial analyses.

2.2.3. Criticism and Limitations of the Chosen Method

When conducting research it is important to be aware of and disclose the limitations that the chosen methodology is subjected to. According to Bryman & Bell (2011) qualitative research in general is often criticized for the impossibility to achieve generalizability and consequently the researcher has to be very critical about generalizations based on such research and case studies. On the other hand the findings are very valuable for theoretical or abstract generalizations, as well as for the understanding of some detailed aspects or contexts (Flyvbjerg, 1988). As the DCF valuation model is aimed at valuing one specific project or company at the time, to undertake a quantitative study would not be suitable since each model set up requires a great deal of adaption to the specific circumstances of the project that is being valued. On a side note, it is also important to state that the generalization problem does exist for researchers despite if they have based their conclusion on larger sets of quantitative data since it is always difficult to generalize between population and different circumstances (Popper, 2002; Lincoln & Guba, 1985). As a result, we are convinced that a case study approach will provide the most valuable in-depth insight into the theory of DCF valuation with Monte Carlo simulation. Moreover, considering the reliability of the chosen method, we are convinced that the conceptual findings described in this study will be translatable and comparable to other studies within similar situations and contexts.

2.3. Theoretical Framework

Regarding the theoretical framework various established theories are used. However, the main focus is on the Discounted Cash Flow (DCF) model and on Monte Carlo Simulation, but also on the Capital Asset Pricing Model (CAPM) for systematic risk assessment since the theory regarding risk and uncertainty is fundamental in the DCF model. In addition to this, statistical distribution types that are relevant when conducting the simulation-based valuation, are assessed.

2.4. Data Collection

The data used in the study is both of quantitative and qualitative nature and has partly been gathered from primarily sources, but mainly from secondary sources since most of the data where already available and not specifically collected for this study.

2.4.1. Quantitative Data Collection

In this thesis, data based on peer companies related to DONG Energy and wind power investments is used. The quantitative data related to these companies has been collected from the database *Thomson One*. The access provided by Copenhagen Business School (CBS), whereby we feel confident in using this database. Thomson One has collected the data based on the widely used and accepted databases DataStream and Worldscope. For consistency, the aim has been to collect all market data of the publicly trade peers from one database since we assume that it has been estimated in the same way. Related comparable data for DONG Energy has been collected from the DONG Energy's 2012 annual report as it provides the most current data available at the time.

Additional market data has also been collected to estimate the risk free interest rate, the market risk premium and the actual yield to maturity on bonds issued by DONG Energy.

The data used to estimate the actual risk free rate is collected from statistics of international market rates available from the central bank of Sweden (Sveriges Riksbank, 2013). Based on suggestions in academic literature, the latest issued long term Government bonds were used for estimating the risk free rate (Koller, et al., 2010).

In order to estimate the market risk premium used in the valuations we have collected historical index data from NASDAQ OMX Nordic. 10 years of monthly data was used from the stock index KAX, which includes all stocks traded on the Copenhagen Stock Exchange, weighted by their market capitalization. Koller, et al. (2010) also motivated the choice of this timeframe as appropriate for estimating the market risk premium, whereby we decided to use this time period in the study. The actual cost of DONG Energy's debt was estimated by using the yield to maturity on the last issued bonds as it represents a fair current market value according to economic valuation literature (Titman & Martin, 2011). The market data for the bonds was collected from the Frankfurt Stock Exchange.

Furthermore, the expertise at DONG Energy has provided quantitative data related to the case specific inputs related to wind power investments. Despite that the overall goal of the study is to assess the results in an objective way it has been a necessity to use this kind of subjective expert data since many cost estimates related to wind farm investments would have been impossible to get in another way. Still it is important to note that the quantitative input data are based on realistic market values even though they are only collected from DONG Energy as the only source.

2.4.2. Qualitative primary data

In addition to the above secondary data collection, two informal interviews with personnel involved in the valuation process at DONG Energy were conducted in order to gain deeper understanding of how the transition to the Monte Carlo based methodology has affected the valuation process. The data gathered during the interviews will only be used in the discussion of the case study since the aim is to get additional input of qualitative aspects of the shift to a Monte Carlo based valuation process. The interviews were arranged as semi-structured based on open questions (see Appendix 12:12 for details regarding the questions) since the aim was to let the respondent to answer freely, based on their own experience of the simulation based valuation approach (Bryman & Bell, 2011).

The first person interviewed was Andreas Nahne Nickelsen, Senior Financial Analyst in Investment Analysis in Wind Power Division at DONG Energy A/S. Nahne Nickelsen was interviewed due to his involvement with the finance department responsible for the valuation. The second person interviewed was Emelie Zakrisson, Team Leader within Project Costing in the Wind Power Division at DONG Energy A/S and was chosen to be interviewed due to her involvement in collecting input estimates for valuation purposes and her role as an intermediary between the input providers and the finance department.

3. Theory

This chapter aims to present the relevant theories for this study and how they are properly used in project valuation. First the reader will be introduced to the DCF model and its inputs, as well as CAPM. These theoretical concepts are applicable for both the deterministic and the simulation based valuation approaches utilized in the later presented case study. In the last part of this chapter the Monte Carlo method and various statistical distributions are introduced.

3.1. The Discounted Cash Flow Model

As discussed in the introductory chapter the DCF model is the standard valuation method used within capital budgeting in practice and is widely accepted according to precious research (Graham & Harvey, 2001; Correia, 2012; Brunzell, et al., 2013). Even in cases where valuation is based on alternative methods such as real options, decision trees, the idea of the DCF is included in order to assess the planned path of the investment.

The DCF model considers three important parameters; the *time value of money*, *future cash flows* and *project risk* (Brealey, et al., 2011). The objective of the model is to estimate future cash flow streams and discount these to a present value according to the illustrating Figure 2 below. Consequently the time value of money, implying that a certain amount of money is worth more today than in the future is included in the model. As illustrated in Figure 2, the cash flow streams are matched with the future time when they are expected to occur and discounted backwards and only the *free cash flow* (FCF) and the *discount rate* used affect the result of the valuation, namely the *net present value* (NPV) (Brealey, et al., 2011, Petersen & Plenborg, 2012).

Figure 2: Example of the DCF Model

Inputs	
Sales year 1	10 000
g	10 %
Fixed costs year 1	2 500
Fixed Costs growth	5 %
Variable Cose (% sales)	50 %
Discount rate	7 %

Year	0	1	2	3	4	5
Sales		10 000	11 000	12 100	13 310	14 641
Fixed Costs		2 500	2 625	2 756	2 894	3 039
Variable Costs		5 000	5 500	6 050	6 655	7 321
Initial Investment	-10 000					
Cash Flow Stream$_t$		2 500	2 875	3 294	3 761	4 282
DCF$_t$		2 336	2 511	2 689	2 869	3 053
NPV	3 458					

Source: Own construction

3.1.1. The Choice of Cash Flow Level

When performing a DCF valuation several assumptions and choices have to be made. Concerning the cash flows to be discounted, there are two main levels that could be used for project valuation (Petersen & Plenborg, 2012). The first alternative is to estimate the project free cash flow (PFCF), which is the cash flow to both creditors and equity holders. This approach is called the project value approach. The second approach is called the equity value approach and accordingly the free cash flow to equity (EFCF) holders is assessed. The cash flow to equity holders thus has to be separated from the net present value of debt and discounted to the return on equity (r_e). As a result, the EFCF represents the cash flow produced by an unlevered project that can be distributed to the firm's equity holders (Titman & Martin, 2011). However, the classic and most well-known approach is to estimate the PFCF e.g. to use the enterprise or project value approach. This version of the model is often referred to as the standard model and is also the model that is used in the thesis.

3.1.2. Decision Making in DCF Valuation

There are several ways that the DCF model can be used to support investment decisions and the two most commonly used investment criterions are based on the net present value (NPV) and the internal rate of return (IRR) (see Appendix 13:13) (Graham & Harvey, 2001; Ryan & Ryan, 2002; Brounen, et al., 2004).

Decision Making Based on NPV

The NPV method has a wide appeal as it considers projects with different size, timing of cash flows and even mutually exclusive projects. For example a smaller project could for example generate a higher rate of return than a lager project, with regard to the capital invested but still a lower total amount of cash. This issue is considered by the NPV since it correspond the estimated total amount of money that a specific project is expected to generate. The same logic is true for mutually exclusive project, where the project generating the largest amount of cash should be taken if only one project is to be chosen (Brealey, et al., 2011).

To calculate the NPV, the amount and timing of future cash flows, the initial investment outlay as well as the discount rate adjusted for risk and time value of money must be identified.

$$NPV = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_n}{(1+r)^n}$$ **Equation 1**

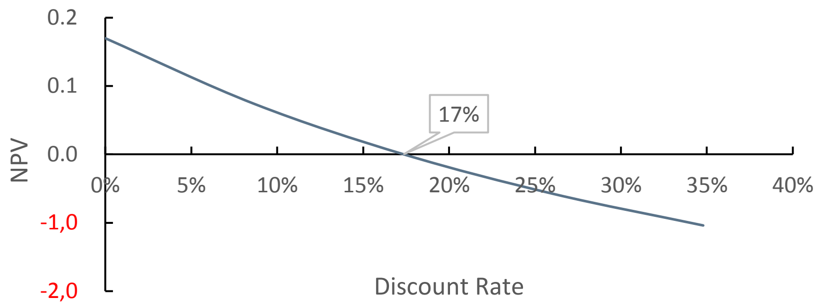
Source: Sydæter & Hammond (2008)

As can be seen based on Equation 1 the procedure for valuating an investment according to the NPV is straightforward. In its most simple form the investment decision is then based on the “NPV rule” which implies that if the investment shows a positive NPV it is an investment worth to take on (Brealey, et al., 2011).

Decision Making Based on IRR

According to survey evidence, using the IRR as an investment criterion is essentially as common as using the NPV (Graham & Harvey, 2001). The IRR can be interpreted as the discount rate for which the NPV is zero. It is used for calculating which interest rate the cash flow creation equals, in a situation where the expected cash flows from an investment are known. Considering this, calculating the IRR is done by setting the NPV formula (Equation 1) equal to zero. By then solving for the discount rate, the IRR is obtained. Finding the IRR is illustrated graphically in Figure 3 (Berk & DeMarzo, 2006; Brealey, et al., 2011).

Figure 3: Finding the Internal Rate of Return



Source: Own constructions based on (Berk & DeMarzo, 2006; Brealey, et al., 2011)

Solving the NPV formula (Equation 1) for the discount rate (r) normally requires the usage of a trial and error approach for obtaining the sought after value. It cannot be done analytically for multiple period models since it may result in several possible values (Berk & DeMarzo, 2006); Brealey, et al., 2011).

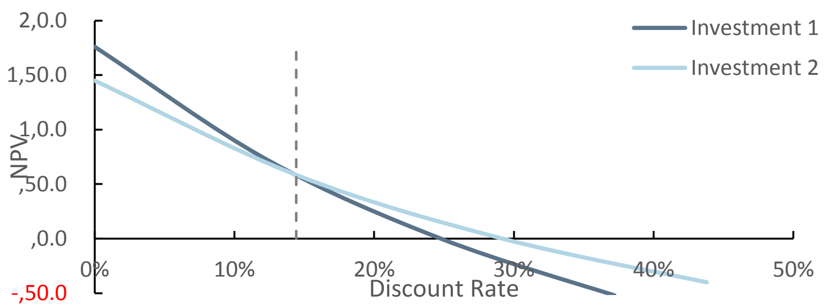
The IRR Rule and Internal Rate of Return as an investment criterion

While calculating the IRR does not require a known opportunity cost of capital, using the IRR as an investment criterion indeed does. The *IRR rule* says that any investment opportunity should be accepted as long as the IRR is larger than the opportunity cost of capital. By examining Equation 1 it is obvious that discounting the cash flows at a rate lower than the IRR, the NPV has to be larger than zero. Since according to the NPV rule, any investment opportunity with a positive NPV should be accepted, the IRR rule will give the same answer to question whether an investment opportunity should accepted or not (Brealey, et al., 2011).

Comparing Investments Using IRR

When comparing two potential investments using IRR as a profitability measure, one investment might be more profitable, suggesting that this would be a better investment. While this would be true if the investments are equally large, assuming the same opportunity cost of capital in both cases, it does not necessarily apply when the investments differ in size. Even though the investment with the larger IRR is expected to generate more cash in relation to its investment cost, the actual cash generation in absolute numbers might be lower. This could be the result if the investment with the lower IRR is expected to generate much larger cash flows, but due to large initial investment expenses the IRR will be lower (Brealey, et al., 2011). This situation is illustrated in Figure 4 where using a discount rate below 14 % results in Investment 1 having a larger estimated NPV compared to Investment 2, while the IRR will be larger for Investment 2, regardless of the discount rate.

Figure 4: IRR for Mutually Exclusive Projects



Source: Own construction

3.2. Discount Rate

The discount rate used in the DCF-model should according to theory be risk adjusted and consequently address the time value of money and the estimated level of risk subjected to the investment (Brealey, et al., 2011). Basically the discount rate should be seen as the opportunity cost of investing in the specific project, compared to other investment facing the same risk level. As a result the investor is compensated for taking on the investment cost today and for bearing the estimated risk throughout the investment lifetime. Considering a company as a whole, the discount rate used for valuing the entire firm should match the expected return on a portfolio of all the company's existing assets. Hence when applying this logic in project valuation, single projects should be valued as if they were mini-firms. In practice, this means that the firm should discount the cash flow of a project at the expected rate of return that investors would demand to make a separate investment in this project (Brealey, et al., 2011). Concerning the discount rate in the DCF model, it is important to note that the discount rate only compensates for the downside, that is, the risk of losing money, but not for potential upside chances of making more money than expected (Kodukula & Papudesu, 2006). This implies that every level of added risk regarding the investment project (increased volatility to market movements) is reflected in a higher discount rate, which in turn lowers the present value of the cash flows. Since the intention of this thesis is to construct a model where the project free cash flow is estimated (see section 3.1.1) it is common practice to use a weighted average cost of capital (WACC), which is the weighted rate of return relevant for a mix of debt and equity investors.

3.2.1. WACC

The WACC model is the standard method for estimating discount rate used in the DCF model (Brealey, et al., 2011, Titman & Martin, 2011). The main benefit is that the rates of return required by different investors are weighted together. The formula below is used to calculate the WACC in the standard case were only debt and equity is used for financing the investment.

$$WACC = \frac{E}{E+D} r_e + \frac{D}{E+D} r_d (1-t)$$

Equation 2

Source: Brealey, et al. (2011)

Equation 2 clarifies how the return on equity (r_e) and cost of debt (r_d) are weighted together according to the relative values of equity (E) and debt (D). Further, it incorporates the effect on taxes (t) caused by interest payments on the debt. The prediction of the WACC is that is corresponds the minimum return that the project investors need to cover in order to satisfy its specific mix of capital investors (debt and equity providers). In addition the WACC formula also reflects the average of the after-tax cost of various sources of invested capital, which is another general strength of the model. The interpretation is that because interest payments are deductible, that is that the government pays part of the total cost of debt, the after tax cost of debt $r_d (1 - t)$ should be used for WACC calculations (Brigham & Ehrhardt, 2011). This advantage is thus picked up in the DCF framework through a lower discount rate and not as larger cash flows (Brealey, et al., 2011). Related to the discussion above concerning the different cash flow levels, the WACC is the relevant cost of capital to estimate the value of the free cash flow to all investors (Petersen & Plenborg, 2012).

Regarding the capital structure weights inserted in the WACC formula, it is important that the components used to calculate the WACC reflects the current importance of each source of financing, which is best estimated using market values (Koller, et al., 2010, Titman & Martin, 2011). That is, the costs of capital used for capital budgeting purposes should always reflect the current required returns as far as it is possible and not historical values, and hence the WACC should reflect the current opportunity cost of capital based on market values (Brealey, et al., 2011, Titman & Martin, 2011).

Another important detail regarding the use of the WACC is that it is based on the firm's current characteristics even though it is used to discount future cash flows. Thus the assumption is that the firm's risk level as well as debt ratio remains constant (Brealey, et al., 2011). Therefore, if the debt ratio or business risk changes over time, the WACC should be recalculated appropriately to reflect the new opportunity cost of capital. This relationship was investigated be Modigliani and Miller in their famous Proposition 2, which says that the rate of return to equity investors increases as the firm's debt-equity ratio increases (Modigliani & Miller, 1958).

To be able to estimate a relevant WACC it is necessary to first estimate the inputs in the WACC. In the following passages, the theoretic way of estimating the WACC inputs is presented, starting with the cost of debt.

3.2.2. Cost of Debt

The cost of debt is the rate of return required by suppliers of the firm's debt. Financial literature suggests that the cost of the most recently issued corporate bonds issued by the company itself are the most relevant estimates of cost of debt. Alternatively, corporate bonds issued by corporations with an equal credit rating to the company considering the investment can be used when no own bonds are issued (Baker & Powell, 2009; Koller, et al., 2010). Brealey, et al. (2011) gives a similar indication; "Always use an up-to-date interest rate, not the interest rate when the firm's debt was first issued and not the coupon rate on the debt's book value". Further, Baker & Powell (2009, p. 346) says; "…if the bonds are investment-graded (rated BBB or higher) and publicly traded, the yield to maturity (YTM) on outstanding debt is a reasonable estimate of the cost of capital". If the current price of traded bonds, the coupon rate and the schedule of principal payments are all known the cost of debt can be estimated by solving for the YTM through trial and error in to Equation 3 below, where P_0 is the current price of the bond, C_t is the future coupon payments at times 1 to n, and F is the principal payment at time n, and Y is the yield-to-maturity.

$$P_0 = \sum_{t=1}^{n} \frac{C_t}{(1+Y)^t} + \frac{F}{(1+Y)^n}$$

Equation 3

Source: Asgharian & Nordén (2007)

The same logic is described by Koller, et al. (2010) and Titman & Martin (2011) who indicates that the bond yield is considered a reasonable estimate of the cost of debt financing, only when the risk of default, is so low that the *promised* cash flow from bonds (interest and principal) are a reasonable estimates of the *expected* cash flow to the bond holders. In contrast, for lower rated bonds, the *expected* and the *promised* cash flow are not the same and certain adjustments is necessary. The distinction between high and low rated bonds is made based upon the grading where investment-grade bonds (BBB or higher) are considered to be high rated bonds. That is, for BBB graded or higher bonds, the YTM could be used as a good approximation for the cost of debt (Titman & Martin, 2011). Further, as an investment decision dependent on a project's forecasted future returns, the cost of new or marginal capital should be used (Brigham & Ehrhardt, 2011). This makes sense since the cost of new marginal debt, most probably, will not be the same as the average rate on previously issued debt (Brigham & Daves, 2012). This is a reasonable argument for using the YTM of the most recently issued bonds as an estimate of the cost of debt that potential new bondholders will require (Brigham & Ehrhardt, 2011).

3.2.3. Return on Equity

Estimating of the return on equity is probably the most difficult cost input to estimate in the WACC formula. This since the equity holders are residual claimants of the cash flow and their return is not stated on a financial contract as in the case of debt holders. Contrary to the cost of debt, the return on equity is an estimated *required* return that the equity holders are estimated to demand on their invested capital, not actual outgoing payments as in the case of the return to debt providers.

Asset pricing models

Various methods exist in the literature that all seek to estimate the risk adjusted return that asset holder demand for investing. The single most common model used to estimate the cost on equity within corporate finance is the *Capital Asset Pricing Model*, abbreviated CAPM (Bruner, et al., 1998; Graham & Harvey, 2001; Bancel & Mittoo, 2004; Brounen, et al., 2004). The model was first published by Sharpe (1964) and is an extension of the portfolio theory developed by Harry Markowitz, with the new notion that risk could be divided into systematic market risk and risk specific to a company. Sharpe and Markowitz were even awarded with the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 1990 for their work in the development of the Capital Asset Pricing Model together with Merton Miller (Sveriges Riksbank, 2012). The model is based on modern portfolio theory and assumes that the market reflects all risk that is not diversifiable and that all other kinds of risk can be diversified away in a portfolio of different assets (Brealey, et al., 2011). There are also alternative pricing models used to determine the cost on equity, and among these the arbitrage pricing theory (APT) developed by Ross (1976) and the three-factor model developed by Fama & French (1995) belongs to the most classic. The APT seek to relate the expected return on a financial asset in a linear function of different macro-economic factors where each factor is subjected to a specific beta (Brealey, et al., 2011).

Considering the alternative models, empirical evidence shows that the three-factor model better explains historical returns according to Titman & Martin (2011, p. 124), who also makes a good statement concerning this result; "…the three factor model better explains historical returns than the traditional one-factor CAPM, which is not surprising given that the model was designed to explain these returns…". Further, the authors argue that since the return on equity is forward looking one must believe that historical returns is a good indicator of future return to use the three-factor model, otherwise the CAPM is to prefer since it has a better theoretical foundation. However, common for the estimation models is that investors require a higher return for taking on more risk (Brealey, et al., 2011).

Within this thesis, the CAPM model is used as it is the standard text book model and as it is widely used by many corporations in their forward looking capital budgeting decisions and capital structure decisions (Graham & Harvey, 2001; Grayburn, et al., 2002; Romano, 2005) (Gray & Hall, 2006; Brown & Walter, 2013). Graham & Harvey (2001) for example, found that 73.5 % of U.S. Managers used CAPM and the second most used model to estimate the return on equity was past average stock returns. Brounen, et al. (2004) found that CAPM is less popular in Europe even though it is the most popular method;" […] CAPM is the most popular method of estimating the cost of equity capital in Europe: in the U.K., Netherlands, Germany and France, 47.1%, 55.6%, 34%, and 45.2% of CFOs relies on the CAPM for estimating the cost of equity […]" (Brounen, et al., 2004, p. 9).

CAPM

The CAPM model as shown in Equation 4 states a linear relationship between the expected return on an asset (in this case the return on equity, r_e), the beta for this asset, β_e, the expected market return, r_m and the risk-free rate, r_f.

$$r_e = r_f + \beta_e \left(r_m - r_f\right)$$

Equation 4

Source: Brealey, et al. (2011)

Accordingly the only investment or company specific factor is the beta. The other model inputs are assumed to be the same for all firms. As a result, both the expected market return and the risk-free rate should be the same for all investments. The beta measures the sensitivity of the movement in returns of the specific investment, relative to the movements in returns of the market as a whole. Consequently the beta expresses the portion of market risk exposure to which an investment is subjected to since it scales the market risk premium ($r_m - r_f$) according to the amount of expected return on an asset that is explained by the market return. The return on equity therefore only depends on the risk relative to the market and not on the source of capital and could thus be estimated independently of the preferences of various investors (Myers, 1984). The idea behind the logic was investigated by Markowitz (1952) and implies that investors can diversify away all but the systematic market risk. Therefore, the systematic risk is the only risk that investors should be compensated for according to CAPM. To make this conclusion, several assumptions stand behind the model (see Appendix 14:14) (Brealey, et al., 2011).

The risk free rate

The risk-free rate defines how much an investor can earn on the investments without incurring any risk. Since it is considered to not hold any risk, the beta for a risk-free investment is zero and thus it is not affected by the size of the beta in the CAPM formula. Ideally, for the accuracy of the DCF analysis, the risk-free rate can be estimated by using the interest rate of a government bond with a duration corresponding to the length of the investment (Koller, et al., 2010).

Market Risk Premium

According to CAPM, as previously indicated, risk is divided into two categories; *systematic* risk, which is a non-diversifiable risk stemming from the market (macroeconomic factors) and company or project specific *non-systematic* risk referring to all kind of diversifiable risk, which is all but not the market risk. The systematic risk threatens all companies with various effects dependent upon how sensitive a project or a company is to the market volatility. This market-wide risk thus reflects that some investments are riskier than others and that investors should be compensated for undertaking risk that cannot be diversified away. Consequently investments highly correlated to the market risk should be discounted at a higher discount rate in order to compensate investors for bearing the non-diversifiable market risk (Bodie, et al., 2011). Therefore, the non-systematic company specific risk on the other hand could, according to CAPM, can be diversified away and consequently investors should not be compensated for bearing this risk. The logic behind the categorizing of risk is that it can be assumed that by holding a portfolio of diversified assets, an investor can diversify all the company specific risk away ending up solely exposed to market risk (Brealey, et al., 2011). The subdivision of risk allows investors to only consider the systematic risk when estimating an appropriate return on equity.

The market risk premium $(r_m - r_f)$ can be defined as the excess return that all rational investors expects to receive as compensation in addition to the risk free rate for taking on systematic risk. To estimate this spread between the risk risk-free rate and the expected return on market various approaches could be used. There are three general categories for performing this task. The first method is the ”implied method” were forward looking premiums are estimated based on various market rates or prices on traded assets today (Koller, et al., 2010; Damodaran, 2012). There are different methods used but most of them are based on regression or option-pricing models were the chosen market index is the underlying asset. Using the second approach, the market risk premium is estimated with current financial ratios. To predict the market risk premium one should regress the excess market return against a financial ratio (Koller, et al., 2010). The third approach is to estimate the returns earned on equities in the past relative to riskless investments and use the historical premium as a prediction of the future. When using this approach it is important to use historical returns for the same market index used to calculate beta, and to compare the return over the same time horizon as that used for the risk-free rate (Berk & DeMarzo, 2006). Still, the historical return method faces some problems and this topic is frequently discussed in financial literature. The main issues are regarding the fact that historical returns vary widely over time, which results in large estimation errors. If the actual market index used has performed very well during the historical period, the estimates may be too high and conversely if the market has underperformed the estimates may be too low, to use for predicting the future (Titman & Martin, 2011).

Damodaran (2012) tested different models and found a market risk premium, pending in the range between 3.07 % and 6.15 %. Thus, it is possible to conclude that there is no single approach that is the better than the other and to choose an appropriate market risk premium requires educated guesses and assumptions about the specific market and its future as the market risk premium de facto cannot be observed (Koller, et al., 2010). Further, it is important to note that the choice of a market risk premium may affect the valuation result more than the firm specific inputs of cash flow and beta, which makes the quality of the estimation of market risk premium essential for performing a satisfactory DCF valuation. Nevertheless, despite its drawbacks we have chosen to use historical values when estimating the market risk premium since this is considered the standard textbook method (Titman & Martin, 2011; Koller, et al., 2010) and since the main focus of this thesis is not to investigate the market risk premium. Further, Koller, et al. (2010) argues that if the level of long-term average risk aversion of investors has not changed over the years, then historical excess returns should be a reasonable estimation for future premiums. When averaging historical data, the widely accepted statistical principle is that the arithmetic average is the best unbiased estimator. Estimating the market risk premium as the arithmetic average of historical observations is performed as shown in Equation 5 where $(r_m - r_f)_t$ is the realized market premium at time t, and the sum of these is then divided by n number of observations.

$$\text{Market Risk Premium} = \frac{1}{n}\sum_{t=1}^{n}\left(r_m - r_f\right)_t$$ **Equation 5**

Source: Koller, et al. (2010)

Beta

In practice there are various methods estimating CAPM beta. Practitioners use different time horizons and various smoothing factors could be added in order to calculate different adjusted betas. For companies listed on stock exchanges, the standard method to estimate the beta is by performing a regression analysis of past stock returns with the returns of the market portfolio as the explanatory variable (Berk & DeMarzo, 2006; Bodie, et al., 2011).

Estimating beta, β_e, for a firm by linear regression analysis is performed by regressing the excess returns above the risk free rate, r_f, from the firm's stock, r_e, with the market return premium, $r_e - r_m$, as the explanatory variable. This is shown in Equation 6 where α is the intercept and e_t is the regression error.

$$\left(r_e - r_f\right)_t = \alpha + \beta_e\left(r_m - r_f\right)_t + e_t$$ **Equation 6**

Source: Titman & Martin (2011)

Alternatively, the beta can be estimated as the relationship between the covariance of investment with the one of the market in relation to the variance of the market index as in Equation 7 where $\sigma_{i,m}$ is the covariance between returns of stock *i*, and the market index returns, and σ_m^2 is the variance of the market index returns.

$$\beta_e = \frac{\sigma_{i,m}}{\sigma_m^2}$$ **Equation 7**

Source: Bodie, et al. (2011)

When estimating beta, the choice of historical return period must be considered. Researchers have indicated that the return period used for estimating beta should match the estimated investment period. Regarding the reference period it should include at least 60 data points and monthly returns should be used since more frequent return periods would lead to systematic biases (Koller, et al., 2010; Mukherji, 2009). Further, the market index has greater explanatory power for longer return periods than it does for daily returns (Mukherji, 2009). Thus the use the five years monthly returns will be used for all estimations based on historical estimates as far it is possible within this thesis[1]. Lastly, it is important to note that the above mentioned beta estimation procedures is only applicable to publicly traded companies, whereby the beta estimation procedure has to be extended to fit within this study (see section 3.3.1).

3.3. Discount Rate Estimation in Project Valuation

In order to estimate a reasonable discount rate for non-traded constellations such as *projects*, *company divisions* and also *privately held companies* various additional assumptions and estimations is often necessary to made in order to estimate a WACC based on return on equity

[1] This choice was made since the time five years estimation period has been confirmed by empirical research as appropriate (Black, 1972).

according to CAPM. The WACC and the CAPM method is however still the most used methods but, since for example the beta formulae above refer to publicly traded companies, it is not possible to estimate a beta for a project using these formulae, whereby alternative approaches are used (Graham & Harvey, 2001; Meier & Tarhan, 2007).

In addition, the choice of discount rate is much affected by the source of project financing, i.e. if the project is financed on or off the firm's balance sheet. These issues will be investigated from a theoretical from a theoretical point of view in the following sections and later applied to the case study undertaken in chapter 4, where the two case projects are valued.

3.3.1. Estimating the Return on Equity for Non-listed ventures

When estimating the proper discount rate for *privately held companies* or for *projects* and *company divisions* facing a risk level different from the one of the overall company, the theoretically most correct approach is to estimate a WACC where the cost of equity is derived based on a beta estimating procedure. The procedure of estimating a beta under these circumstances however differs from cases where a traded stock can be used for estimation purposes as in Equation 6 or Equation 7 above.

Due to the absence of an observable beta value, a commonly used technique is to estimate betas according to Equation 6 or Equation 7 for stock exchange-listed competitors, known as a peer companies, and then assume that the company or project being valued faces the same sensitivity to the market as its peers (Titman & Martin, 2011). This approach suggests that an average beta of publicly traded peer firms is used.

When using Equation 6 or Equation 7, to estimate the beta for the peer companies, is important to note that the obtained beta includes both operational and financial risk. This beta is partially determined based on the peer company's capital structure and is known as *equity beta* or *levered beta*. In order to apply this beta to the object being valued the peer company's financial risk has to be excluded from the beta value. This is performed by *unlevering* the beta value according to Equation 8 for each firm in the peer group and the resulting value is known as the *asset beta* or *unlevered beta*. It is then common practice to use the average unlevered betas for the peer companies to obtain a usable unlevered beta. To be able to use this beta value for the company or project being valued, it is necessary to *relever* this beta and thereby adjusting it to the capital structure of the venture being valued according to Equation 9. The resulting value is the equity beta adjusted to the capital structure of the valuation object. It is important to note that in practice, it is common to use the book value of debt and to set the debt beta, β_d, to zero[2].

$$\beta_A = \frac{\beta_E + \beta_D (1-t)\frac{D}{E}}{1+(1-t)\frac{D}{E}}$$ **Equation 8**

Source: Brealey, et al. (2011)

$$\beta_E = \beta_A \left[1+(1+t)\frac{E}{D} \right] - \beta_D (1-t)\frac{D}{E}$$ **Equation 9**

Source: Brealey, et al. (2011)

In the above equations β_E is the beta of the company unaffected by financial leverage, β_A is beta of the company affected by financial leverage, β_D is the beta of the company debt, *D is* book value of debt for the company and *E* is the value of equity of the company and *t* is the marginal tax rate.

This procedure is undertaken since variations in the beta value between companies vary not only due to which industry the companies operate in, but also due to the capital structure of the companies. Firms using higher debt ratios have larger levered betas due to increased risk for equity holders as they are residual claimants in case of default. The average unlevered peer group asset beta (β_a) is therefore estimated, in order to eliminate differences due to financial leverage. As a result, the unlevered beta only measures the operating risk in the industry based on the assumption that all companies in an industry shares the same risk profile. Further, using the average among peers seeks to minimize the estimation errors subject to individual estimates by the assumption that such errors is average out if using more peer companies (Koller, et al., 2010). The factors affecting the unlevered beta are the cyclicality of the industry and the operational leverage of the industry. The operational leverage refers to the production facility and if it is associated with high fixed costs compared to variable (Brealey, et al., 2011). To

[2] Since most company debt is not usually traded on the market, if even at all, it is customary to use book value of debt. As a result the β_D is also set to zero since the cost of debt in many cases is contracted (Titman & Martin, 2011).

estimate the systematic risk relevant for the project being valued, the unlevered peer group beta then must be relevered by using the capital structure of the own company or project (Petersen & Plenborg, 2012).

3.3.2. Subjective Discount Rates Estimation

A second approach used in practice is to estimate project or divisional discount rates refers to using subjective judgments, fudge factors or risk premiums (Meier & Tarhan, 2007; Brealey, et al., 2011; Brunzell, et al., 2013). Since this method is subjective, naturally no direct applicable theory exists and these kinds of methods are consequently not consistent with financial theory. Under this approach the analyst uses different methods to estimate a discount rate used for company divisions or projects to match their risk. Since this can be seen as a "black box", it is impossible to explain how companies actually do this in practice. Recently published articles suggest various reasons for subjectively estimating the discount rates with methods that could be referred to as "rules of thumb", where the reasons for setting a subjective discount rate could be associated with *over-optimism*, *agency problems* related to get projects approved, accounting for elements related to *real options*, *political risk*s, as well as to *bounded rationality* (Brunzell, et al., 2013; Holmén & Pramborg, 2006; Poterba & Summer, 1995). Poterba & Summer (1995) for example, found that managers set higher discount rates, above required rate of return, to correct for too optimistic cash flows. Berkovitch & Israel (2004) found that agency problems in divisionally organized firms was a reason for divisions to set discount rates, which get their projects approved from the head quarter.

Two relevant studies on the topic was undertaken by Brunzell, et al. (2013) and Meier & Tarhan (2007), who found that in project valuations companies used premiums that yielded discount rates higher than when using empirical inputs for debt and equity estimated by CAPM. Brunzell, et al. (2013) surveyed Nordic firms and Meier & Tarhan (2007) surveyed 127 US companies. The research by Brunzell, et al. (2013) indicates that pressure for short-term results, embedded real options and agency problems were important reasons for changing the discount rate subjectively upward.

Also related to this study, are the determinants found of the *equity premium puzzle* by (Meier & Tarhan, 2007). By regressing data from US firms, they found that the reasons for using subjectively estimated discount rates can be related to financial flexibility, managers' nonconfidence in the estimates of beta, and past performance of the industry. Interesting is also that the researchers found that companies to some extent included unsystematic risk in their discount rates, despite that they used CAPM to estimate the systematic risk. Based on interviews with the CFOs of the surveyed companies, they could confirm that the systematic risk were more important than the non-systematic risk even though some portion of both were included in the discount rate. The portion of subjective adjustments to the project cost of capital increased as the confidence regarding the beta estimates declined. Risk aversion behavior was given as explanation for the increased adjustment when the statistics was less reliable. Furthermore they concluded that the premium originated from the equity side in the WACC formula as the debt side was considered as stable.

In conclusion Brunzell, et al. (2013) estimated based on their study of Nordic firms that the subjective premium included in the discount rate ranged from -4.12 % to + 18.92 %, with an average of 3.99 % above the estimated WACC. Meier & Tarhan (2007) found a range of risk premiums of -6.96 % to 21.07 %. The average added premium as in the range of 5.28 % to 7.5 %, depending on which assumption about the market risk premium used in the WACC calculations. Nevertheless, both studies confirmed that firms make use of project specific discount rates that on average are higher than justified by economic theory (CAPM). To estimate the size of the subjectively added premiums, both studies compared the answers from interviews with own WACC calculations for each company, based on financial data acquired from databases.

3.3.3. Financing Options

In general projects are financed on the firm's balance sheet (corporate finance) or financed off-balance sheet (project finance) using special purpose entities (SPE). An SPE is an entity created to carry out a specific purpose or activity and which is separated from the company. The choice of financing structure often affects the discount rate, whereby this issue is briefly discussed even though it is not the main purpose of this study. The main difference is that if project finance is used, the project is valued in such a way that it could bear its own debt on a stand-alone basis. Among companies however, most investments are based on corporate financing. This means that the funds used to finance an investment project comes directly from the company as a whole. Consequently it is hard to determine the appropriate discount rate for a specific project under these circumstances since the project is not separated from the company as a whole and the cost of financing the specific project cannot be directly identified (Titman & Martin, 2011). According to CAPM, companies should in this case identify a specific beta that is estimated to indicate the relation to the market risk for the specific project.

Furthermore, in order to estimate the project-specific WACC, an estimation of the project specific cost of debt and return on equity is required, which is often a difficult task, especially with balance sheet financing. Concerning the debt in the case of project finance, the project is often financed using nonrecourse debt with the project cash flow as collateral. As a result, investments projects that are project financed are very similar to an independent firm (Yescombe, 2002; Titman & Martin, 2011). In this case it is more straightforward to calculate the project specific WACC since the source of debt financing is observed, which is not the case for on balance sheet financing. However, in the case of project financing it is more demanding to estimate the return on equity, especially if the weights of debt and equity change during the lifetime of the project. In this case it is necessary to relever the beta continuously to reflect the current return on equity, which in turn depends on debt ratio according to the Modigliani and Miller theorem previously discussed. In comparison, when estimating a project specific WACC with company balance sheet financing, the theoretically correct procedure is to estimate the amount of company debt and equity that could be attributed to the specific project. This is done by estimating the project debt capacity (Brealey, et al., 2011; Titman & Martin, 2011). In general, projects with a larger amount of risk have a lower debt capacity and vice versa (Brealey, et al., 2011). In order to estimate the project debt capacity, the most important risk is the volatility of the projects cash flow compared to that of the company as a whole. Increased cash flow volatility compared to the firms overall cash flow volatility implies lower debt capacity and vice versa. For example, if the firm has an optimal capital structure and future estimated cash flows of the project faces an increased systematic risk compared to the firm average, the debt capacity for the project has to be lowered. This lower weight is then included when estimating the project WACC by using the company cost of debt and equity respectively (Titman & Martin, 2011). However, if a project that is financed with the company balance sheet can be considered to bear a risk similar to the average of the whole company, it is possible to assume an unchanged debt capacity. Consequently it is possible to use the company's overall debt equity weights and cost of capital when valuing projects in these situations (Brealey, et al., 2011). In this case study, presented in chapter 4, the projects are assumed to be financed by DONG Energy's balance sheet, which thus requires that the market based capital structure of DONG Energy is estimated.

3.4. Risk in the DCF Model

This section aims to evaluate the risk related aspects of the DCF model. This refers not only to the assessment of risk, but also the inclusion of risk in the investment valuation.

3.4.1. Risk Analysis in the DCF Model

While non-systematic risk in investment valuation can be analyzed by many methods, two of the most common procedures that directly relates to riskiness of the valuation model inputs are the sensitivity analysis and the scenario analysis presented below (Ryan & Ryan, 2002).

Sensitivity Analysis

Sensitivity analysis is a tool that allows decision makers to identify which investment value drivers that may have the largest impact on the final project value. The sensitivity analysis is performed based on an already constructed financial valuation model that calculates the project value based on the most likely value estimates for all included investment value drivers. However, as the most likely inputs estimates in reality can undertake other values than the most likely value, the evaluation of the input estimates is often recommended (Jovanovic, 1999; Koller, et al., 2010).

Performing the sensitivity analysis is done by individually setting the model inputs to their most pessimistic values, as well as their most optimistic. The project value is then registered for each pessimistic and optimistic case, for each individual variable. The result is a set of ranges, on for each analyzed input variable. These ranges represent the worst possible project value and the best possible project value based on the changes in one input variable, holding all other variables constant at their most likely value (Brealey, et al., 2011). While the sensitivity analysis does not represent any realistic cases, the purpose of the analysis is to find which input variables that may cause the project value to deviate the most from its most likely value. Lastly, it is common to present the results from the sensitivity analysis graphically with a *tornado chart* which compares the different input variables' impact on the project value (Berk & DeMarzo, 2006; Mehta, 2013).

Scenario Analysis

Scenario analysis is performed by extending the sensitivity analysis instead of identifying the effects of changes in one specific input variable at the time, analyzing the effect on the investment value under different *key scenarios*. Such scenarios can for example be based on future possible macroeconomic related situations or test additional strategies, such as lowering the sales price and including the estimated changes in related input variables, such as the number of units sold (Brealey, et al., 2011).

A more basic use of the scenario analysis tool is to analyze the worst case scenario and the best case scenario. The worst case scenario is constructed by setting all valuation model value drivers to their estimated most pessimistic value and in practice this means for example setting costs at their largest values and revenue at its smallest estimated possible value. The best case scenario is the exact opposite of the worst case scenario and is thus constructed by setting the model input variables to their most optimistic values. Both these two scenarios have an extremely small, or even non-existing probability of occurring. However the resulting investment values in terms of for example NPV and IRR defines the absolute bounds in-between the value of the investment may lay (Mathews, 2009; Clark, et al., 2010).

3.4.2. Risk Adjustment in the DCF Model

The result of DCF valuations are very much determined by how risk is included in the valuation process. While the inclusion of systematic risk is fundamental in the DCF model, accounting for non-systematic risk is also a tremendously important aspect of investment decision making.

Systematic Risk in the DCF Framework

As previously explained the WACC is commonly used as the discount rate in the DCF model. Furthermore, the return on equity is assumed to be in proportion to the underlying systematic risk. Consequently a single WACC is not suitable to use for all potential projects for a company. A company-wide WACC is only appropriate to use as discount rate for cash flows with a systematic risk level equal to that of the firm as a whole (Brealey, et al., 2011). However, not all projects undertaken by a given company faces exactly the same risk level. The methodology suggested to use in those cases is to estimate a project specific risk adjusted cost of capital based on CAPM and the beta estimation procedure based on traded peer companies explained in section 3.3.1 above.

Considering the required return on equity, the recommended practice is to estimate a project specific beta based on comparable traded peer companies, which indicate that the market defines the systematic risk attributable to the investment. This step is important and according to Modigliani & Miller (1958), as a key result of corporate finance theory is consequently that a project's cash flows must be discounted at a rate that reflects the underlying systematic risk characteristics of the specific project. Thus it is important that firms adjust the beta for the project risk level and thereby the cost of capital in order to fit the project. In this discussion it is important to be clear about that this risk adjustment according to CAPM only concerns the systematic and non-diversifiable project risk. This result is directly derived from one of the important CAPM assumptions, which states that all other kind of project non-systematic risk is diversifiable (see Appendix 14:14). Furthermore this is expressed by Brealey, et al. (2011) who make it clear that the cash flows are assumed to unbiased. The non-diversifiable market risk is generally accepted as the risk that can be captured in the value of a traded security or the risk of a projects future payoff that is driven by market forces (Amram & Kulatilaka, 2000; Kodukula & Papudesu, 2006).

Non-systematic Risk in the DCF Framework

According to the CAPM discussion above, the market risk is addressed through the beta that if correctly applied generates a risk-adjusted discount rate. Hence this risk should not be confused with the uncertainty or volatility that concerns the input estimates and indirectly the cash flow estimates. This risk is considered as private and investors should not be compensated for bearing this kind of project specific risks, which is related to efficiency of the organization in completing projects (Kodukula & Papudesu, 2006). The market risk that is included in the unlevered beta should solely relate to the risk that the industry faces due to the characteristics of the products brought to the market. This risk is therefore regarded as non-diversifiable or systematic and should be accounted for in the WACC. However, considering an investment project, it is not only subject to the systematic market risk but also to more project specific uncertainties regarding the cash flows and the inputs estimates. This kind of uncertainty should be adjusted for through the cash flows in the DCF model by adjusting them according to the probability of success. This since the cash flows are supposed to be unbiased forecast giving equal weight to all possible outcomes (Brealey, et al., 2011). In practice however, the input estimates and thus the estimated cash flows are often educated guesses that includes subjective judgments (Knull, et al., 2007).

The uncertainty or volatility that is attributable to the inputs is often too complex to completely differentiate into market risk and non-market risk, which would be necessary if the final cash flows estimated should be unbiased. Therefore it seems reasonable to assume that the cost inputs used in the DCF framework often include risks from many sources that could affect the cash flow estimates, independently if diversifiable or not. This is also the intuitive reason that practitioners do not discount cash flows to a risk free rate even though a project seems to only be affected by uncertainty not related to the market risk (Kodukula & Papudesu, 2006).

Risk Adjustments in the DCF Framework

According to the problem discussion in section 1.2 and the DCF framework using CAPM, there are two possible ways for risk-adjustments. The first alternative is to adjust the cash flows for the full range of potential outcomes, and then weighting the resulting cash flows by their individual probabilities. This proceeding is based upon the CAPM requirement of perfect information, which is needed if the analyst should be able to give the right weight to every outcome. The second alterative that affects the output is to increase or adjust the discount rate or the beta for inaccurate cash flow forecasts (Brealey, et al., 2011; Ruback, 2011) In practice many companies tend to adjust the DCF valuation by changing the risk adjusted discount rates in favor of adjusting the cash flows for potential downside and upside, which is directly related to the discussion above regarding the subjective approach to discount rate estimation (see section 3.3.2).

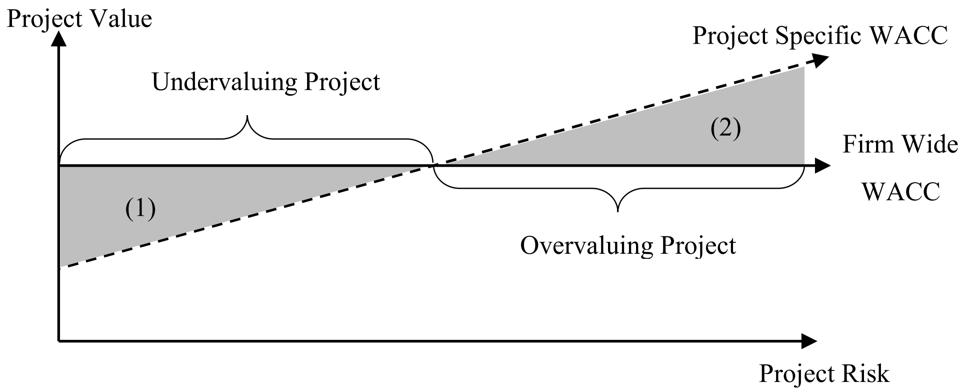
Poterba & Summer (1995) surveyed American companies and found that most of them adjusted the discount rate rather than the cash flows. This can be referred to as they use a hurdle rate, which is a discount rate that exceeds the appropriate cost of capital for the project (Titman & Martin, 2011). This result has been confirmed by Berkovitz, et al. (2009) who found that most cash flows used in project valuations are based on a “base case” scenario that does not include potential severe scenarios since this is more challenging than to adjust the discount rate. These findings do however diverge from what academics suggests according to the above discussion of non-systematic risk, e.g. that it is wrong to add what is referred to “fudge factors” to the discount rate if managers fail to give all cash flow outcomes their right weight. To add fudge factors to the discount rate in order to offset thing that could go wrong is dangerous and the need for such adjustments is merely arises because managers have failed to give bad outcomes their right weight when estimating the cash flows (Brealey, et al., 2011). Despite which method is the best one it is possible to conclude that various approaches are applied to the problem in practice, according to previous research.

Survey evidence concerning Capital Budgeting

In contrast to the correct theory explained above, survey evidence from companies suggests that it is not only common to use adjusted discount rates, but also common that firms perform capital budgeting using the company WACC for all investment valuations. That is, they do not adjust the project discount rate at all for differences in systematic risk according to CAPM. Graham & Harvey (2001) show that a large majority (58.8 %) of firms use the company WACC to value projects independently of risk level. Similar results was found by Bierman (1993) who surveyed the top 100 firms of the Fortune 500 and found that 93% of the firms used their company WACC to value projects. Brounen, et al. (2004) surveyed European firms and could also conclude that most of the firms used the company-wide discount rate to evaluate projects and less than one third used a risk-matched discount rate. Bruner, et al. (1998) found additional intuitive results based on their survey. The researchers could, based on their study conclude that when firms can establish benchmarks by identifying data from peers, then they adjusts the project beta. In case the companies could not find any benchmarks they used the company WACC and adjusted the cash flows to compensate for all potential risks and uncertain cash flow estimates. In contrast however, they found that almost all financial advisors indicate using an adjusted project WACC according to theory. The difference was explained by the fact that financial advisors are specialized in finance and more familiar with the sophisticated textbook methods.

Based on previous studies, it is thus possible to acknowledge that using the same WACC for all projects is common practice. These findings are naturally also opposing the normative theory and would then imply potential distortions in project valuation. Demanding the same company rate of return for all projects suggests that good low-risk projects will be rejected and poor high-risk projects would be accepted (Brealey, et al., 2011; Titman & Martin, 2011; Krüger, et al., 2011). According to the example in Figure 5, project 2 (1) is qualified for a higher (lower) discount rate than the overall firm and if they are discounted with the wrong discount rate it would lead to under or underinvestment.

Figure 5: Effects on Project Value



Source: Own construction based on Titman & Martin (2011)

This issue was especially investigated by Krüger, et al. (2011) who studied if conglomerates non-core division investments increased with the "*beta spread*", calculated as the spread between the implied beta of the division and the company. They found a significant positive correlation in their regression and could, based on their result conclude that divisions that used a company beta lower than the division beta invested more frequently and vice versa. By using the same discount rate, the riskier projects will appear more valuable and result in overinvestment. The authors explain the result with the theory of bounded rationality and referred to the *"irrational manager"* and the literature and research of behavioral corporate finance. Another explanations could be that it is hard to adjust single discount rates for different projects or that many firms engage in a narrow spectrum of activities, which implies that a single discount rate works fine as proxy for all projects (Titman & Martin, 2011).

3.5. Monte Carlo Simulation

While the previous sections have been devoted to outlining the fundamentals in DCF valuation, the following sections are aimed at the concept of Monte Carlo simulation and the inclusion of this method in investment valuation that will be performed in practice in chapter 4.

The Monte Carlo method is a commonly used to approach mathematical problems that are very complex and might even lack an analytical solution. The method has a wide use in finance and while the method of using Monte Carlo simulation does not provide a precise numerical solution to a problem, it does result in a statistical probability distribution of all potential outcomes (Vose, 2000).

Monte Carlo simulation is based on random numbers. If a mathematical relationship is specified that includes uncertain determinants, these variables can be specified as probability distributions. When applying Monte Carlo simulation, a randomly picked number from these distributions will be used for calculating the result of this relationship. This is repeated a specified number of times and the result is sampled after each calculation is finished. When the number of simulations are finished, the result is a complete set of potential outcomes. By dividing these outcomes according to the frequency that they occur, a form of probability distributions can then be constructed (Fishman, 1995; Hubbard, 2007). While the result of the Monte Carlo simulation is presented in the form of an absolute value, it is instead a statistical estimate in which the probability of different values occurring can be derived (Vose, 2000).

3.5.1. Incorporating Monte Carlo Simulation in the DCF Model

Including Monte Carlo simulation in DCF modelling is in practice an extension of the DCF model. The main purpose of this extension is related to the analysis of risk factors that may affect the valuation result. Performing an investment valuation based on Monte Carlo simulation can be seen as a process and in this section the procedure is outlined. It should also be noted that while the model is normally set up in a standard spreadsheet computer application, such as “Microsoft Excel”, any practical application of the Monte Carlo simulation requires specialized software, commonly in the form of an add-in to the spreadsheet application (Grossman, 2008).

When attributing the Monte Carlo simulation process to the DCF modelling, the model have to be prepared for such a simulation process. While it is based on the deterministic DCF model, the model being used for the simulation purpose differs in several important aspects. The key input variables are instead of being entered as static most likely values, entered into the model as statistical probability distributions according to their respective distribution type (see section 3.6 below).

Setting up the basic model to be used for Monte Carlo analysis is essentially the same as constructing a deterministic DCF model that uses static inputs. It also has to follow the same requirements such as properly defining a mathematical relationship between a set of input variables and correctly generating chosen outputs such as NPV and IRR (Rozycki, 2011; Tamošiūnien & Petravičius, 2006). As for all forms of valuation modeling, it is of great importance that when performing "…a forecast with perfect hindsight, the valuation approach must yield an unbiased estimate." (Petersen & Plenborg, 2012, p. 212).

Probabilistic Input Variables

The simulated valuation model is contrary to the deterministic model, not only based on the most likely input values. The input variables in the model are instead defined as probability distribution. Defining the input probabilities involves both choosing the appropriate type of probability distribution, as well as estimating the distribution parameters (Damodaran, 2009). Compared to a regular DCF valuation model based on fixed value inputs for all the different value drivers, incorporating Monte Carlo simulation in the model requires that some, or even all fixed values for the input variables are substituted with probability distributions (Grossman, 2008; Smith, 1994). Estimating the input distributions appropriately is a demanding task but using historical or other types of appropriate data, if available, is a reasonable starting point. In addition to this, the use of personal expertise is of great importance even if usable data is available. For example, even if historical data is used for estimating the distribution inputs, a given input variables might be known to have the characteristics of a specific distribution type (Kelliher & Mahoney, 2000; Brealey, et al., 2011; Damodaran, 2009; Titman & Martin, 2011). Nonetheless, when defining the distribution it will preferably be done by utilizing available knowledge, such as including the appropriate department in the process of estimating the input distributions (Titman & Martin, 2007; Rozycki, 2011).

Since the process of defining the probability distributions can be cumbersome, it is important to be aware of that not all inputs have to be *probabilistic* in a simulated valuation model. It is possible to define a number of key inputs as probability distributions, while keeping other inputs at a fixed value. Some input variables can realistically be considered to have a fixed value, such as payments that are predetermined and are considered certain (Smith, 1994). Further, by using sensitivity analysis, it is possible to identify less significant variables and consider keeping these at a fixed value. Due to them having a relatively low impact on the output, it may not be justifiable to use the resources needed to estimate the variable as a probability distribution (Tamošiūnien & Petravičius, 2006). In this case, the practical application of defining the input distributions means extending our previously built deterministic DCF model to handle the input of distribution parameters instead of solely one static value for each input variable.

Correlations

Further, the existence of correlation between different input variables is a common phenomenon and an important issue to consider when using Monte Carlo simulation in a valuation model (Tamošiūnien & Petravičius, 2006). With two completely uncorrelated variables, it is reasonable to assume that any value can be drawn randomly from each distribution independently. This is not a realistic assumption in any case where there exists a correlation between variables. Randomly picking a number from one of the correlated variables will then mean that not all values for the other variable can be considered possible anymore. Consider for example a situation where a correlation between to different operational costs can be observed. In that case, if one cost is drawn to be a certain amount, the other cost will follow this cost according to their correlation coefficient. The values of the input variables might also depend on additional underlying factors that are not normally included in a valuation model.

It is possible to incorporate such interrelationships between input variables in the simulated model, either by manually including the presence correlations in the model by linking the correlated variables to covariate according to the specified correlation coefficients, or by specifying the correlations in the simulation software and letting it automatically handle them (Titman & Martin, 2007). However, it is a tough challenge to identify the existence of correlated input variables, as well as estimating the actual correlation between the variables (Brealey, et al., 2011). The task of solving this problem has to be done, as with the case of selecting and defining input distributions correctly, by the use of available knowledge and expertise, and if available, also by analyzing historical data (Kelliher & Mahoney, 2000).

After specifying the input variables one has to decide which output variables that are of interest for valuation purposes, since the values of the selected variables will be sampled in the simulation process as they are the subjects for the investment analysis. As in the case with the static DCF analysis, common variables to analyze includes the NPV of the discounted cash flows and the IRR, but not necessary restricted to these (Togo, 2004; Clark, et al., 2010; Rozycki, 2011).

Running the Monte Carlo simulation through specialized add-in software is essentially an automated process, though it will require the user to manually decide how many times the output values will be simulated, known as the number of iterations. The number of simulation runs to be executed depends on the input distributions. In principle, a larger number of probabilistic input variables will require a larger number of iterations, as with the spread in possible values for the inputs and to what extent multiple types of distributions are used. Due to modern computers having well enough power to perform a large number of simulated iterations, there is no actual downside to maximizing the number of simulation runs to achieve a more reliable model output.

When starting the simulation procedure a random value will be drawn from every predefined input probability distribution. The model will then calculate the outputs that previously have been set. This step is identical to any DCF valuation with the exception that the input values are randomly picked from its respective distributions. When the outputs have been calculated, these values are stored to be used for the output statistics. The process will be repeated until the number of iterations completed are equal to the chosen number of simulation runs. When all iterations are finished, the resulting values of the predefined output variables from each run will be cumulated as a set of possible values. These values can then be used for producing informative statistics about the object being valued, such as minimum and maximum value, mean value and standard deviation. These values can in addition to these descriptive statistics be used to define a probability distribution of the outcome, including probabilities for different values to occur and graphical representations of the distributions as for example a histogram chart.

3.6. Probability Distributions

The concept of Monte Carlo simulations is based on the probability of events to occur. Consequently, the understanding of probability theory and how a random variable can be said to be *distributed* according the probability of it taking on a given value, is fundamental. This section explores a selection of probability distributions whose specification makes them interesting for being used as approximations for estimated input variables in simulated DCF valuation model. The four distribution types that are described below are the *uniform distribution*, the *triangular distribution*, the *normal distribution* and lastly the *lognormal distribution*. The choice to explore these four specific distribution types have been made based on discussions in previous research of which distribution types are suitable to use when performing Monte Carlo simulation within the DCF framework. This choice is then confirmed based on information from the conducted interviews with personnel familiar with the topic at DONG Energy, regarding what is used in real-world application of the methodology.

The probability of a random variable's possible values is defined by *probability distributions*. Probability distribution can be divided into two different categories, *discrete* and *continuous*. The notable difference between the two forms has to do with the numbers they can take on. In contrast to the continuous distributions, the probability distributions within the discreet category will only have limited a set of outcomes. This means that if a random variable is estimated to be distributed as a type of discrete distribution, the number of possible outcomes of this random variable is limited. A continuous distribution, on the other hand, can take on virtually any number within the boundaries of its specification, meaning that a random continuously distributed variable have an unlimited number of possible values. This does not mean that the variable can take on *any* value but within the range of possible values, the variable can have any number since it can take on a value with an unlimited number of decimals.

The discrete category of distributions can be exemplified by throwing a dice once. All outcomes are equally probable with a probability if 1/6. Moreover, there are only six possible outcomes for each throw since the thrown dice cannot show a number other than the integers of 1 to 6. This means that outcomes from the dice throw can be described by a discrete, in this case uniform, distribution. Turning to the continuously distributed variables, an example of such is the rate of return for an investment. This financial measure is expressed the payback of an investment in relation to the initial expenditure and can have any possible value with an infinite number of decimals. Another example of continuously distributed variables is the height of humans, since this can be measured to infinitely small fractions of a millimeter (Vose, 2000; DeFusco, et al., 2001).

A large majority of the input variables in a financial models usually relates to the in and out flow of money. Since real money can only be divided in a limited number of fractions, for example expenditures in dollars can at most be expressed in values to the cent, these variables can in fact be considered to be discrete random variables. However, in practice, it is often possible to use a continuous distribution as an approximation of the discrete variables. Making such an approximation is appropriate if the variable values sufficiently large and the steps between the possible discrete values are sufficiently small in comparison, as in the case of large expenditures (Vose, 2000; DeFusco, et al., 2001). Within the framework of this study, the discussed topic relates to a very large extent to large money values, whereby the different probability distribution types discussed in this section are all continuous.

3.6.1. Probability Distributions Suitable in Monte Carlo Analysis

Virtually any type of probability distribution can technically be used when performing Monte Carlo simulations (Rozycki, 2011). As this study involves the topic of using Monte Carlo simulation in the DCF model, a number of probability distribution types stands out as commonly suited as approximations of the uncertain variables incorporated within this framework. According to (Titman & Martin, 2011), the uniform and triangular probability distributions are widely used in Monte Carlo simulation. The uniform distribution are also mentioned by DeFusco, et al. (2001), Togo (2004), Tamošiūnien & Petravičius (2006), Rozycki (2011) and Kelliher & Mahoney (2000). Among other authors who mention the triangular distribution are Kelliher & Mahoney (2000), French & Gabrielli (2004), Togo (2004) and Clark, et al. (2010). The normal distribution is advocated for as a suitable approximation of certain common input variables in simulated capital budgeting models by multiple researchers such as Kelliher & Mahoney (2000), French & Gabrielli (2004), Togo (2004), Tamošiūnien & Petravičius (2006) and Rozycki (2011). Lastly, the slightly more complex lognormal distribution are commonly cited as sometimes appropriate in simulated valuation models French & Gabrielli (2004), Rozycki 2011) and Kelliher & Mahoney (2000).

3.6.2. Continuous Uniform Distribution

To define a variable that is uniformly distributed the only two parameters that have to be estimated are the minimum and maximum value that the variable can possible take on. The uniform distribution does not allow for variable values less than the minimum and correspondingly, values exceeding the maximum. The uniform distribution is defined in such a way that it assign equal probabilities for all values within this range to occur, meaning that no variable value are more or less likely to occur than the other as long as it is equal to, or in between the minimum and maximum values (DeFusco, et al., 2001).

The *probability density function* (PDF) is the mathematical expression for a continuous distributions type. By specifying the function parameters, the probability of a certain value is calculated according to the characteristics of the given distribution type (DeFusco, et al., 2001). According to Vose (2000), however, the probability of a variable taking a specific value if it is continuously distributed is infinitely small since a continuously distributed variable can take on any value within its specified bounds. By firstly specifying the *cumulative distribution function* (CDF) as Equation 10, it can be shown that the CDF defines the probability of a realized value *below* a specifically chosen value. Thus, this function describes the probability for the random variable, X, being equal to or smaller than a specific value, x.

$$F(x) = P(X \leq x)$$

Equation 10

Source: Vose (2000)

The PDF can then be defined by differentiating the CDF and is interpreted as the *rate of change* in the CDF, as expressed in Equation 11.

$$f(x) = \frac{d}{dx} F(x)$$

Equation 11

Source: Own construction based on Vose (2000)

The PDF for a continuous uniform distribution is shown in Equation 12, where a is the minimum value the variable can take on, b is the maximum possible value for the variable and x is a given value of the continuously uniformly distributed variable.

$$f(x) = \begin{cases} \dfrac{1}{b-a} & \text{for } a \leq x \leq b \\ 0 & \text{otherwise} \end{cases}$$

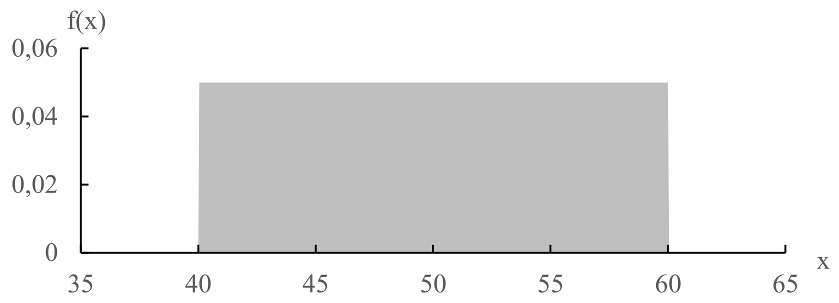
Equation 12

Source: Own construction based on DeFusco, et al. (2001)

Examining Equation 12, it is obvious that the probability for each outcome within the range between the maximum and minimum values is the same. However as also shown, a value less than the minimum specified possible value or for a value larger than the maximum value have a probability of zero and can consequently not occur.

By using the PDF for calculating the probability for large number of values that an examined variable can take on, a graphical representation of the probability distribution for a variable can obtained. This may look as graphed in Figure 6 for a variable that is with a continuous uniform distribution.

Figure 6: Continuous Uniform Distribution



Source: Own construction

The uniform distributed example variable represented in Figure 6 has a minimum possible value 40 and a maximum value of 60. As can be seen all values in between these two extreme values are equally probable to occur, however values below 40 alternatively, above 60 have a zero probability.

Since the uniform distribution is only defined by the estimated variable's smallest and largest possible value, it is convenient when estimating the distribution parameters. Understanding the parameters and thus performing the estimations of these are forthright, making the communication simple both in terms of when requesting estimates of the variable from experts and for the experts when presenting the estimated values for the user of the estimates (Titman & Martin, 2011). In capital budgeting, the uniform distribution is however mostly useful as an approximation of variables whose probability properties are not well-known, such as when there are little available data to back up the estimation of the variable (Vose, 2000).

3.6.3. Triangular Distribution

The triangular distribution is like the uniform distribution bound by a minimum and maximum value. In addition to these two parameters, the triangular distribution is also defined by a third parameter, namely the most likely value. Unlike the uniform distribution, it does not assign equal probabilities for all values within the possible range to occur. Nor does it necessarily impose symmetrical probabilities around the most likely value (compare to the normal distribution in section 3.6.4) due to the possibility of the probability distribution of a triangularly distributed variable being skewed, that is, having a most likely value closer to either the minimum or maximum value. On a last note, the mean of a triangular distribution does not equal the most likely value in case that it is skewed since the mean is calculated as the sum of the minimum and maximum value divided by two (Vose, 2000).

Equation 13 is the PDF for a triangular distribution where the probability for value *x* to occur is a function of the minimum value, *a*, the maximum value, *b*, and the most likely value, *c*.

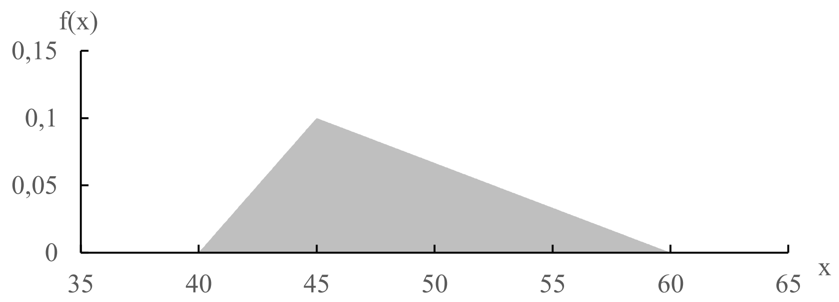
$$f(x) = \begin{cases} \dfrac{2(x-a)}{(b-a)(c-a)} & \text{for } a \le x \le c \\[2ex] \dfrac{2(b-x)}{(b-a)(b-c)} & \text{for } c < x \le b \\[2ex] 0 & \text{otherwise} \end{cases}$$ **Equation 13**

Source: Own construction based on Vose (2000)

The first part of above Equation 13 is the probability of the variable values that are between or equal to the minimum or most likely values and the second part is the corresponding probability for values larger than the most likely value but less than or equal the maximum value. It also states that variable values that do not meet these criterions will have a zero probability to occur.

Graphically, the triangular distribution is constructed by connecting the three estimated values linearly as can be seen in Figure 7.

Figure 7: Triangular Distribution



Source: Own construction

Figure 7 shows a triangular distributed variable with a most likely value of 45 and minimum and maximum values of 40 and 60, respectively. Note that the probability distribution in shown are skewed to the right, assigning larger probabilities of values towards the specified minimum to occur.

The usefulness of the triangular distribution lies in its simplicity, as well as its flexibility. The estimation process of such a distribution is very intuitive since the only three required parameters to be estimated are for this distribution type are the minimum possible variable value, the maximum possible value and the usually always estimated most likely value. For estimation of the variable parameters, understanding and providing estimates of these values are very much straightforward compared to estimating the parameters for more complex distributions, such as the normal and log normal distribution described in the two following sections. (French & Gabrielli, 2004). What makes triangular distribution even more attractive as a probabilistic estimation of an uncertain input variable in a financial model, is that its parameters in many cases would have been estimated even in the case of not applying Monte Carlo simulation to the valuation model. This, because in addition to the normally always estimated most likely value, the minimum and maximum values are often estimated as a basis for the conduction of a scenario analysis that incorporates the worst case and the best case scenario (see section 3.4.1) (Clark, et al., 2010). Further, possibility of the triangular distribution being skewed offers the flexibility of assigning a larger probability to values closer to the minimum or the maximum value (Vose, 2000).

3.6.4. Normal Distribution

The normal distribution is one of the most well-known probability distribution types (French & Gabrielli, 2004). The distribution type is defined by two parameters, the mean and the standard deviation. It is symmetric around the mean (cannot be skewed), meaning that the probabilities of the normal distributed variable taking values below or above the mean are equally decreasing as the distance from the mean increases.

The normal distribution is not bound by any values (Vose, 2000). However most of the normal distribution's probabilities lie in the range of +/- 3 standard deviations from the mean and approximately the probabilities contained within this range is 99 % (DeFusco, et al., 2001).

Equation 14 represents the PDF for the normal distribution and its distribution parameters consisting of the mean and the standard deviation are represented by μ and σ, respectively.

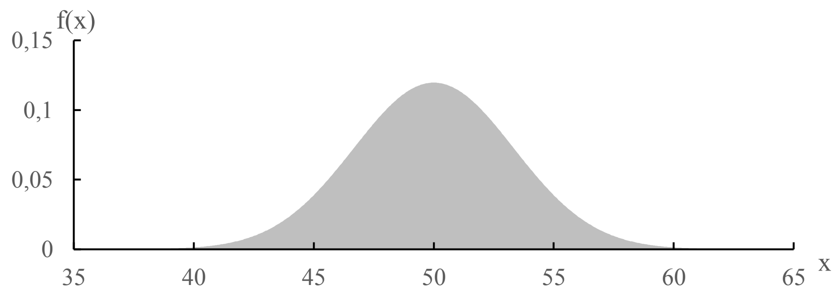
$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$ **Equation 14**

Source: Own construction based on Vose (2000)

The result of the PDF for the normal distribution is that any values where x differs from the mean will result in a smaller probability for that value to occur since in these cases $\exp(y) < 1$ if y is negative and according to Equation 14, this will be the case unless the examined value equals the mean, since $x - \mu = 0$.

As seen in Figure 8, the normal distribution assign symmetrical probabilities of values smaller or larger than the mean and these probabilities are always smaller than the mean (French & Gabrielli, 2004).

Figure 8: Normal Distribution



Source: Own construction

When discussing the usage of the normal distribution it is essential to understand how understand how this distribution type relates to the *central limit theorem*. The central limit theorem is fundamental in probability theory and states that a large sample, drawn from the same distribution will have a normal distributed mean, $\bar{x}$ equal to the population mean, μ and have a standard deviation of the population standard deviation, σ, divided by the sample size, n.

$$\bar{x} = N\left(\mu, \sigma / \sqrt{n}\right)$$

Further, this is also the case when independently sampling variables from different distribution types, as long as the sample is sufficiently large, meaning that the sum and average of such a sample will be normal distributed. The fact that many random variables tend to converge to be normal distributed makes the probability distribution type useful as an approximation in many cases. The normal distribution is also widely used in finance and notably in Modern Portfolio Theory, for example for modelling assets prices. Though prices in contrast to the specifications of the normal distribution cannot have a negative value, the above mentioned approximation that most of the distribution's probabilities will be contained within 3 standard deviations above and below the mean, makes it an often used sufficient approximation in these cases (DeFusco, et al., 2001).

3.6.5. Lognormal Distribution

An interesting trait of the lognormal distribution is that it is a suitable approximation for variables whose value are a result of other positive variables, even with different probability distributions, that are multiplied together. Relating to the central limit theorem discussed in section 3.6.4 regarding normal distributed variables, the reasoning regarding how the sum and average of a sample drawn multiple types of probability distributions will be normal distributed can be extended to the lognormal distribution. In the same way that the sum in the above case are will be normal distributed according to the theorem, the *product* of multiplying a large number variables with different probability distribution types will have a lognormal distribution. The product of multiplying a number of different variables, X_i, is expressed in Equation 15.

$$\Pi = \prod_{i=1}^{n} X_i$$ **Equation 15**

Source: Own construction based on Vose (2000)

Taking the natural logarithm of Equation 15 then results in

$$\ln \Pi = \sum_{i=1}^{n} \ln X_i$$

Since the sum of a large sample will have a normal distribution, ln Π must have a normal distribution, and thus, Π must be lognormal distributed. As the sum of a sample drawn from different types of distribution have a normal distribution, the same argumentation also holds for the product of variables that have different probability distributions, but in this case the product is lognormal distributed. With this in mind, it can be said that the lognormal distribution is like the normal distribution defined by the mean and standard deviation, however of its *associated* normal distribution, that is, the mean and the standard deviation of the natural logarithm of the variable.

The PDF for the lognormal distribution, as well as the equations for obtaining the mean, μ_1, and the standard deviation, σ_1, of the lognormal variable are expressed in Equation 16, where μ and σ are the mean and standard deviation of the associated normal distribution.

$$f(x) = \frac{1}{x\sqrt{2\pi\sigma_1^2}} \exp\left[-\frac{(\ln[x]-\mu_1)^2}{2\sigma_1^2}\right]$$

where

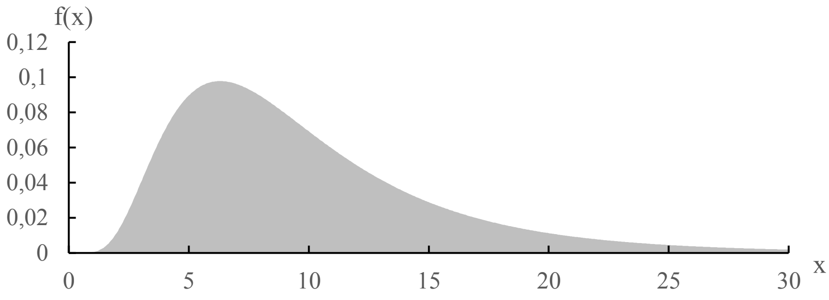
$$\mu_1 = \ln\left[\frac{\mu^2}{\sqrt{\sigma^2+\mu^2}}\right] \qquad \textbf{Equation 16}$$

$$\sigma_1 = \sqrt{\ln\left[\frac{\sigma^2+\mu^2}{\mu^2}\right]}$$

Source: Own construction based on Vose (2000)

While the lognormal distribution has its basis in the normal distribution, the visual representation in Figure 9 reveals that it will be skewed to the right, stretching from zero to infinity (Vose, 2000).

Figure 9: Lognormal Distribution



Source: Own construction

The importance of the central limit theorem this relates to the usage of the lognormal distribution. When estimating the probability distributions of variables whose value is the product of values that themselves are uncertain and even possibly having different distribution types, the lognormal probability distribution is suitable as an approximation.

3.7. Chapter Summary

In this third chapter the reader has been introduced to the theoretical framework relevant for the case study in the subsequent chapter. In the first part of the chapter the basic concepts of the DCF model (time value of money, cash flows and risk) and motivations of the choices specifically relevant for this study has been presented, specifically the chosen cash flow level and decisions making methods (NPV and IRR). Further the CAPM, WACC as well as the estimation procedure of necessary inputs such as project beta, cost of debt and return on equity have been introduced. The effect on the valuation of the financing decision where balance sheet finance is relevant in this case was also presented.

In the later part of the chapter focus has been paid to how the risk is divided between a systematic and a non-systematic part and how both adjustments of discount rate and the value drivers can be used to account for various specific risks in the deterministic DCF model. The commonly used risk analysis tools sensitivity and scenario analysis, that seek to show the dynamics of the valuation to the decision maker was described. In addition, the chapter contains what can be considered the core of the thesis; the Monte Carlo simulation concept that will be incorporated into the DCF framework in the case study. The necessary fundamental mathematical theories of probability distributions and how a random variable can be distributed according to the probability of it taking on a given value in a continuous distribution was lastly introduced to the reader.

4. Case Study

In this chapter the aim is to apply the theories explained in the previous chapter 3 on two investment valuation cases. This chapter features a detailed background description of the valuation cases. This is followed by a walkthrough of the valuation procedure followed. Lastly the result from this case analysis is presented in the last part of the chapter and will be used as a foundation for the discussion in chapter 5.

4.1. Background

To thoroughly investigate both the benefits and the disadvantages associated with using Monte Carlo simulation in conjunction with DCF model for project valuation, this chapter features studies of two realistic investment cases centered on two fictional potential wind park investments in Denmark.

As a starting point, a deterministic DCF analysis with static input values is conducted on both investment opportunities. Sequentially, the deterministic DCF valuation will be extended with both a sensitivity analysis, as well as a scenario analysis being performed on the cases as these are often used as risk analysis tools. Lastly, the investments are analyzed by generating the valuation outputs as statistical distributions using Monte Carlo simulation based on input values defined as probability distributions rather than static values.

To carry out the above described analysis of the two cases, two similar financial valuation models have been constructed in "Microsoft Excel" presented in Appendix 2:2, one for the deterministic analysis and one to be used for the corresponding simulated analysis. The deterministic models is constructed to generate the desired outputs by entering necessary estimated values for input variables whose value will affect the output variables. The models calculate the estimated future cash flows for the projected period and returns estimated static values for the output based on the entered input values. These models are afterwards used as the basis for the Monte Carlo simulation in section 4.9.

For the sake of giving the reader a sense of context, section 4.2 features a general description of the wind power market in Denmark and in section 4.3, DONG Energy is introduced since being the provider of background information necessary to conduct this case analysis.

Furthermore, section 4.4 features a more detailed background description of the two specific cases and is in the subsequent sections follow by a complete breakdown of the specific details surrounding the cases, such as the input variables and their estimated values.

4.2. The Wind Power Market in Denmark

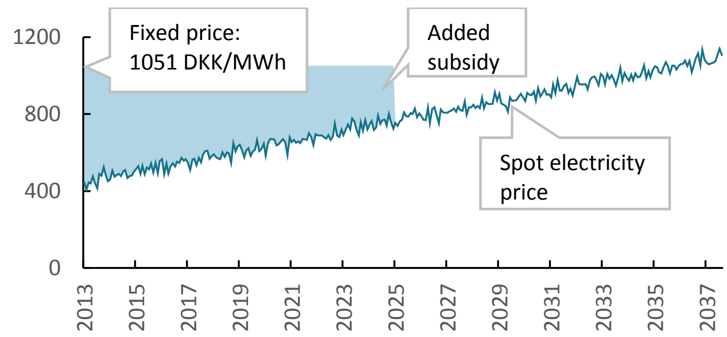
Denmark can be considered the leading country in the EU regarding wind generated electricity. The Danish wind power share of the total domestic energy consumption corresponds to 27.1 %. Comparing this to share of total energy consumption in the EU, only 7 % was in 2012 was generated from wind (The European Wind Energy Association, 2013).

Wind generated electricity in Denmark is subsidized (with the purpose of increasing the share of renewable energy production). Subsidies are granted for all new built wind turbines based on regulations implemented in the summer of 2008. The standard subsidy is paid per produced KWh as a premium to the electricity provider and is currently fixed at DKK 0.023 per KWh with an additional DKK 0.25 per KWh for the first 22,000 full load hours[3]. However, turning to what is referred to as "special wind farms" which are larger commercial projects, the granted subsidies are a result of a tender bidding process and the electricity subsidy may be substantially larger than the previously described standard case. Subsidies for such wind farm developments may instead of having the form of a fixed premium paid out on top of the price at which the electricity is sold at, be compensated with a fixed feed-in-tariff. This can be seen as a guaranteed price at which the electricity is sold at. As long as the electricity price is lower than the predefined feed-in-tariff, the difference will be paid out as a subsidy (Danish Energy Agency, u.d.).

As seen in example in Figure 10, the energy price might fluctuate over the project lifetime, but with the subsidies the income per unit sold will be held constant during the duration of the subsidies, illustrated as the solid color area. In this example the price is fixed at a rate of 1051 DKK per produced and sold MWh. However, this subsidy regime is expected to end in the year 2025 and this time an onwards, the income will only come from the spot electricity market.

[3] Full load hours = average annual production divided by the turbines nominal power.

Figure 10: Relationship between Feed-in-Tariff Subsidies and Energy Price



Source: Own construction

4.3. DONG Energy A/S

DONG Energy in its current form was established as recently as in 2006 and has approximately 7,000 employees and a yearly revenue (2012) of DKK 67.2 billion. This makes the company to the largest Danish power producer with a market share of about 50 % for electricity production. DONG Energy is involved in different businesses within the sector which includes Oil and natural gas exploration and production, Electricity generation at both power stations and renewable energy facilities, Natural gas and electricity distribution, Sales and energy advice.

The electricity generation has been a branch of the company since early days of electricity generation and is of todays is primarily generated at wind farms and by coal, gas and biomass-fired plants in Denmark, Norway, the Netherlands and UK. The activities are divided into five distinct business segments that contributed to the total 2012 years figures for DONG Energy, according to Table 1.

Table 1: DONG Energy Business Segments

DKK billion (Share)	Exploration & Production	Wind Power	Thermal Power	Energy Markets	Sales & Distribution
Revenue	11.9 (14 %)	7.8 (9 %)	9.0 (10 %)	41.4 (47 %)	17.1 (20 %)
EBITDA	6.6 (76 %)	2.5 (29 %)	2.1 (24 %)	-4.6 (-53 %)	2.1 (24 %)
Gross Investments	5.1 (26 %)	(12.7 (65 %)	0.3 (2.0 %)	0.3 (1 %)	1.2 (6 %)

Source: DONG Energy A/S (2013a)

Considering the wind power segment, the business within which the case study is performed, DONG Energy has a strong history. The company has more than 20 years of experience of offshore wind farm development, a track record that makes DONG Energy one of the current global market leaders. According to DONG Energy, they have built more offshore wind farms than any other company in the world and DONG Energy has built 38 % of the European capacity. The wind power section is also where the most investments are made by DONG Energy at the moment, which indicates its importance to the company. During 2012, 65 % of the gross investments were dedicated to wind power. The wind farms are, as most of DONG Energy's business, predominantly based on Northwestern Europe and the company is investing heavily in wind farms off shore. As a result, the company has six additional offshore farms that will come online until 2015. Among these, the London Array Offshore wind farm that became operational in April 2013, are among the most well-known as it is the world's largest offshore wind farm.

The main future goal for DONG Energy is to remain a market leader within offshore wind power production, which is the fastest growing renewable energy technology in Europe. A related goal is to make wind energy competitive compared to other sources of energy, which means that the cost of energy must be reduced to below EUR 100/MWh, a goal that DONG Energy aims to reach in the year 2020. This corresponds to a cost reduction of approximately 30 % compared to the costs that were present in 2011. Further the company aims to become a leader within the biomass-to-energy production and to convert coal power stations to biomass stations. Thus one can conclude that DONG Energy has a strong focus on transforming the power production to become more renewable and sustainable.

4.4. Project Descriptions

This case study has its basis in the analysis of what can be considered two mutually exclusive investment prospects in offshore wind farms in Denmark. The investments are valued from DONG Energy's point of view, which is important to note since the discount rate presented in section 4.7 is based on the capital structure of DONG Energy. The ventures analyzed are very much similar and based on the same basic project. However, the two differs in two important aspects considering the values for a few selected input variables, namely the most likely value for these inputs, as well as their estimated risk. The basis for deriving electricity from wind is the wind turbine generators (WTG). These are the commonly placed on tall towers that converts the kinetic energy from wind to mechanical energy that then is used to produce the electricity. Hence the most important factor to consider is of course the wind resources, since with no wind, there cannot be any production. Relating to the power production, the first project, from here on called “Project A” is assumed to be planned at a site where the wind resources are less than for the site where the second project, “Project B”, is being considered to be constructed at.

While the wind resources provides a larger estimated output for the wind park in Project B, measured wind data in this case are subjected to more uncertainty than the data for the site where the potential Project A possibly will be built. The reason for the uncertainties is that the wind data for the site where Project A will potentially be built is measured on site over a timespan of more than two years. Project B is being considered at a site where the wind data have been measured onshore and then extrapolated[4] to equivalent wind data for the offshore site and additionally, the measuring period is less than two years. The results is that the measured value of wind resources for Project B is more unreliable than the corresponding value for Project A and therefore the production is more likely to differ from its most likely value in the case of Project B. Moreover, certain geotechnical conditions relating to the seabed consisting of rocky soil on the site where Project B is planned, result in increased risks surrounding the installation of foundations. These tougher conditions means a larger downside cost risk, hence the maximum possible cost for the installation is larger than for Project A.

Relating to the sales of the produced electricity, both wind parks are supposed to receive its revenue streams from domestic sales in Denmark. This means that they are both subjected to the same market risk regarding electricity prices and other market related factors. It is also assumed that all electricity produced will be sold immediately at the, at the time of production, current spot price. Further, since the subsidized electricity price is market specific and the size of the wind parks are equal, the granted government subsidies are decided to have the same size regardless of which wind park is constructed. As the two projects are subjected to the same systematic risk as a result of them operating in the same market, the beta and consequently the WACC used as discount rate when estimating the project NPVs, is assumed to be identical. This is in accordance to the CAPM theory that states that beta should only capture market risk, hence the resulting WACC should not be adjusted for project specific risks (see section 3.2.3).

The above discussed differences in specific risk between Project A and Project B are further incorporated in the valuation models through input variables later described in section 4.5.

[4] The onshore measured wind data is transformed to an estimated offshore equivalent.

Relating to every other aspect of the investment and the operation of the wind parks, the two projects are identical. Other than inputs that are specifically pointed out to differ between the two potential investments, the value drivers are identical both in terms of their most likely values, as well as the estimated associated risk of these values. Also in terms of variables that not directly linked to the operation or the investment phase of the wind parks, the projects are alike. More specifically, the projects feature both the same number of wind turbine generators and the generators are made by the same manufacturer and are of the same model.

Lastly, it is important to note that the purpose with this case study is to investigate the methodology of using Monte Carlo simulation in the DCF model, not to make valuations and comparisons of actual potential investments in wind farms, relating to the purpose and the research question of this study noted in section 1.3. However, while the two investment cases are in fact not studies of actual projects carried out or contemplated in reality, they can both very much be considered realistic as the two investment cases have been constructed to resemble as realistic projects as possible with all input data based on market values.

4.5. Input Variables

To the extent that it is possible, the inputs variables have been estimated based on reliable historical data. For the variables that are practically impossible to estimate as outsiders, through discussions with experts at DONG Energy, reliable reasonable market values have been obtained for the estimates, as mentioned in section 2.4.1 about quantitative data collection.

4.5.1. Production

The two case projects are based on two wind farms consisting of 50 Siemens 154[5] wind turbine generators with a nominal power of 6 MW each, resulting in a total nominal power output for each wind farm of 300 MW. The specifications for the wind turbine generators together with the wind resources at each building site are the foundation for the estimated production output. In Project A, each turbines are estimated to produce at full capacity 45 % of the time on average, meaning that the estimated yearly output is 23,652 MWh per turbine. In the case of Project B, the turbines are estimated to produce at full capacity 50 % of the time with a nominal output of 26,280 MWh per turbine. This is calculated by multiplying the nominal output for the turbines

[5] Product specification of the wind turbines available from Siemens Wind Power A/S (2011)

(6 MW) with the capacity factor (45 % and 50 %, respectively) and the number of hours per year (8 760 hours). This is in turn multiplied by the total number of wind turbine generators, which in both cases is 50, to obtain the total most likely output for each wind park. The result is an estimated yearly output of 1,182,600 MWh for the whole wind farm prospect in Project A and 1,314,000 MWh in Project B.

Based on the discussion above, the capacity factor is simulated as normal distributed with a most likely value of 45 % with a standard deviation of 8 % for Project A, and the corresponding values of 50 % for the most likely value with a 12 % standard deviation for Project B. These estimations together with the specifications for the turbines and the probability distribution types were provided by DONG Energy and are summarized in Table 2.

Table 2: Capacity Factor

% of max yearly output	Most likely	σ	Distribution
Capacity Factor, Project A	45 %	8 %	Normal
Capacity Factor, Project B	50 %	12 %	Normal

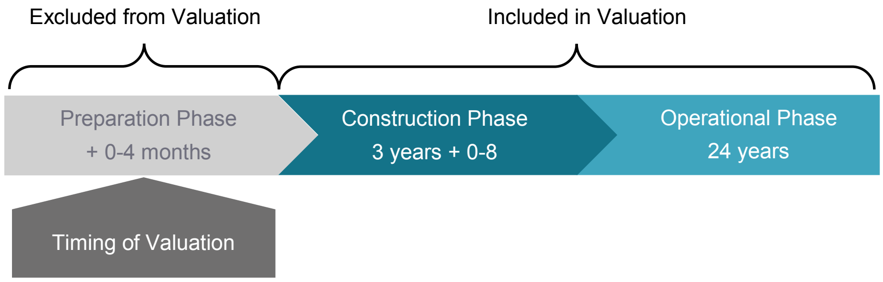
Source: Own construction based on values from experts at DONG Energy

The most likely values are used as input in the deterministic models and these values together with the standard deviations and distribution types are used in the simulated models. The difference in most likely values for capacity factors refers to the difference in measured wind resources for the building sites. Further, the different standard deviations between the projects relates to the differences in quality of the measurements between the two locations, discussed in section 4.4 above.

4.5.2. Timing

The timing of both projects can be divided into three different stages with the first stage being focused on preparation and examination of the potential project. This investment analysis is assumed to take place during this phase, after the prospecting is finished, hence the investment decision has not been made at this stage. However, this also means that all the preparation work and prospecting has deemed both locations as viable, making strategic real options non-applicable at this stage of the valuation, as discussed in section 1.5.1. An overview of the phases and how this valuation relates to the overall timing of the project is displayed in Figure 11.

Figure 11: Timing



Source: Own construction based on input from experts at DONG Energy

The above described preparation phase is followed by a construction phase during which the capital investments take place. The last stage is the operation phase, which is expected to commence as soon as construction is finished. However, the wind turbine generators are expected to come online linearly and start to produce electricity over the first five months of operations as they are finished being built, meaning that the number of operational turbines will gradually increase from zero to 50 during these five months.

Further, three possible causes for delays are included in the analysis, as these are considered significant uncertainties in offshore wind farm construction. The delays consists of one cause for delaying the start of construction with up to 4 months and two causes potentially extending the construction phase with up to 8 months total. All of these delays may in turn postpone the beginning of operations with up to 12 months in total. The different phases of the projects' lifetimes are found in Table 3 together with the duration and expected start date and end date.

Table 3: Timing

Stage	Duration	Start Date	End Date
Preparation	0 – 4 months		2013-12-31
Construction	3 years – 3 years, 8 months	2014-01-01	2016-12-31
Operation	24 years	2017-01-01	2035-12-31
Project	**27 – 28 years**	**2014-01-01**	**2035-12-41**

Source: Own construction based on values from experts at DONG Energy

For valuation purposes, the wind park is estimated to have an operative lifetime of 24 years and hence the depreciation period for the assets is set to 24 years to match the estimated lifetime of the operation. This is a standard time period used by DONG Energy when writing down the assets of a wind park and valuing the potential investment.

4.5.3. Electricity Price Components

The revenue streams from the wind farms in the valuation models are derived solely from sales of the produced electricity and consists of two components, spot electricity price and government subsidies, as described in section 4.2. The spot electricity price is measured as DKK per MWh and is set by the market and will consequently vary over the lifetime of the project while the granted subsidies are predefined are in fact not a source of uncertainty.

Energy Prices

For estimating the power price, historical data for Denmark obtained from Nord Pool Spot for the last ten years have been used (see Appendix 4:4 for details regarding the estimation). The observed power prices are divided into two different regions in Denmark. As a result of this, an average for these two regions for every observation date have been used.

Examining monthly observations reveals that the power prices are very volatile with a monthly standard deviation of 28 %. Studying annual data however, indicates that the power prices tend to even out over the year. Since our model uses annual periods for all calculations, taking this into account is important since the volatility of the monthly power prices makes these observations unjustifiable to be used in the models. By turning to the annual observation, standard deviation was found to be 20 % for the annual power prices.

Figure 12: Historical Monthly Electricity Prices

Source: Own construction based on data from Nord Pool Spot

Further, by conducting a time series regression analysis of the same data, the power prices have been estimated to grow by 0.94 DKK per produced and sold MWh, monthly and transformed to annual values 11.32 DKK per MWh.

Table 4: Electricity Price

Initial Value	320 DKK/MWh
Annual Growth	10 DKK/MWh
Minimum/Maximum	+/- 20 %

Source: Own construction based on data from Nord Pool Spot

With this regression analysis as a basis and through discussions with experts at the matter from DONG Energy, the consensus that fluctuations in the price corresponding to 20 % above and under the most likely value for the yearly average electricity price variations have been reached. With these discussions with experts in mind, for the deterministic DCF model, the input value for the power prices is estimated to increase by 10 DKK per MWh for each year of the project and the value for the first year will be based on the latest observation.

Turning to the simulation analysis, since using the annual observation results in a small sample, the electricity prices are approximated as triangular distributed rather than for example normal distributed, relating to the discussion regarding probability distribution types in section 3.6. The probability distributed is estimated with a minimum value of 20 % below the most likely value and 20 % above the most likely value. For the most likely value, as for the deterministic DCF, 320 DKK/MWh have been used as a starting point, with a yearly growth of DKK 10/MWh.

Subsidies

Within the case study, the subsidies are predefined and can be considered a guaranteed price per produced unit of electricity. The parameters of the price subsidy is based on the real-world example of DONG Energy's Anholt wind farm as it is the subject to a recently completed bidding process in Denmark (Danish Energy Agency, u.d.), as well as discussions with experts at DONG Energy. According to this, the price subsidy have been estimated to be 1051 DKK per MWh produced (in the form of a feed-in-tariff explained in section 4.2 above). This is the guaranteed price per MWh during the subsidies lifetime, meaning that the difference between the spot electricity price and the predetermined value of 1051 DKK will be paid out as a subsidy, assuming that the spot electricity price is below this value. In this case analysis the wind farm operator will only be granted this subsidy for the first 15 TWh[6] produced and after producing this accumulated output the subsidies will be cut. This value corresponds to the subsidies for the Anholt wind farm, where the subsidies is granted for the first 20 TWh. The Anholt wind farm has a nominal power of 400 MW and projects in the case analysis 300 MW, therefore scaling the granted amount of subsidies results in a value of 15 TWh for this case (DONG Energy A/S, u.d.). Based on the estimated values of production in this case, this is estimated to occur in year 2028, during the 12th year of operations for Project A and for Project B this expected to happen in 2027, the 11th year of operations. The slightly earlier most likely end date for the subsidies for Project B is related to the higher predicted level of production.

4.5.4. Capital Expenditures

The estimated values for the capital expenditures is based on an offshore wind farm with a total nominal power output of 300 MW. All estimated values, as well as the timing of the capital expenditures are also in this case derived from discussion with experts at the matter at DONG Energy. The investments take place in the second phase illustrated in Figure 11 and is divided over the course of three years, where the investment in the first year will make up 30 % of the total invested capital, 60 % in the second year and in the last year 10 %. In Table 5 below, the capital expenditures for the whole wind parks are listed together with their minimum, maximum and most likely values. As with the capacity factor, the most likely values are used as model inputs in the deterministic DCF. Also, the type of statistical distribution shown, and in the cases where the variable being assumed to be normal distributed, the standard deviations are listed. Relating to the theoretical implications of the different probability distribution types (see section 3.6), the normal distributed input variables in the simulation based models are approximated with this distribution type due to more extensive historical data analyzed. Whereas the variables are denoted triangular distributed, these cannot reliably be considered normal distributed and hence the triangular probability distribution is used.

Comparing the values stated in Table 5 reveals the difference in capital expenditures between the Project A and Project B. Project B has a larger risk for the cost of installing the foundations to deviate and being larger than the most likely value. As discussed in section 4.4, this is due to the uncertainties inherent from the seabed at the construction site for Project B consisting of

[6] 1 TWh equals 1,000,000 MWh

tougher rocky soil than in the case of Project A. This means that due to complications during the installation, the cost might rise more above the most likely value than for the same variable for Project A.

Table 5: Capital Expenditures, Project A[7]

	Both Projects		Project A	Project B	Both Projects	
DKK million	Min	Most Likely	Max	Max	σ	Distribution
Resource Cost	470.8	495.6	594.7	594.7		Triangular
External Consultancy costs	137.3	140.1	142.9	142.9		Triangular
Overall Project Costs	768.5	784.2	799.9	799.9		Triangular
WTG	3,242.4	3,242.4	3,242.4	3,242.4		Triangular
WTG – Other	238.8	238.8	238.8	238.8		Triangular
WTG Installation	331.2	348.6	418.3	418.3		Triangular
Foundations	801.4	843.6	885.8	885.8		Triangular
Installation of Foundations	824.8	868.2	1,041.8	1,172.0		Triangular
Array Cable Supply	96.6	101.7	106.8	106.8		Triangular
Installation of Array Cables	480.5	505.8	607.0	607.0		Triangular
Offshore Substation, SCADA	577.1	588.9	600.7	600.7	2 %	Normal
Onshore Substation	382.8	390.6	398.4	398.4	2 %	Normal
O&M Facilities & Equipment	52.9	54.0	55.1	55.1	2 %	Normal
Total	**8,405.2**	**8,602.5**	**9,132.6**	**9,262.8**		

Source: Own construction based on values from experts at DONG Energy

When performing the deterministic DCF valuation, the most likely values from Table 5 have been used as the input values. The minimum and maximum values are then the foundation for extending the analysis to studying the impact of different variables in the sensitivity analysis. These values are also used when examining different possible outcomes in the scenario analysis by constructing the worst-case and best-case scenario. Moreover, when using the input values in the simulation analysis, all input variables denoted as “Triangular” are estimated as triangular distributed defined by their respective minimum, maximum and most likely values. The variables indicated “Normal” are estimated as normal distributed whose mean is the most likely value, with a standard deviation according to the column labeled σ (sigma).

4.5.5. Operational Expenditures

The yearly operational expenditures (see Appendix 3:3 for details) are assumed to be identical for both Project A and Project B and are presented in Table 6 together with their minimum,

[7] An explanation of the different capital expenditures can be found in Appendix 3:3.

maximum and most likely value, type of distribution, as well as standard deviation in case the specific cost is normal distributed. As with the capital expenditures, the minimum and maximum estimates and the standard deviation is to be used in the simulated DCF model when defining the input variables as probability distributions. Also, the minimum and maximum values are used for the sensitivity and scenario analysis for the deterministic DCF models.

Table 6: Operational Expenditures

DKK million	Min	Most Likely	Max	σ	Distribution
WTGs	31.4	33.0	39.6		Triangular
Foundations	8.8	9.0	9.2	2 %	Normal
Transmission Assets	22.8	24.0	28.8		Triangular
Systems	39.6	41.7	50.0		Triangular
Technical Resources	6.2	6.3	6.4	2 %	Normal
Logistics & Facilities	23.2	23.7	24.2	2 %	Normal
Administration	15.9	16.2	16.5	2 %	Normal
Insurance	2.6	2.7	2.8	2 %	Normal
Fees, Taxes, Environment	49.1	50.1	51.1	2 %	Normal
Total	**199.6**	**206.7**	**228.6**		

Source: Own construction based on values from experts at DONG Energy

The values are based on the full 300 WTG wind park and presented in yearly figures. As in the case with the capital expenditures, the estimated values are results from discussions with experts at DONG Energy and are realistic market values for a wind park of this size.

4.5.6. Delay

A very important cause for project specific risk that has a substantial impact on the value of the projects is that they are somehow delayed. For this reason, three types of possible reasons for project delays have been incorporated in the models. These three reasons are considered to be the most significant reasons for delays to account for when valuing the investments, according to the providers of the case study at DONG Energy. The first reason for project delays is due to issues with consents and may occur before the actual investment takes place. The second and third cause for delays is due to problems with the transporting vessels and due to inefficient installations. These two types of delay have a probability to occur during the construction phase. All of the delay reasons may only occur before the wind farm is operational, hence delaying the operations and the streams of revenue. Also, as seen in section 4.5.4, the delays will affect the value of several of the inputs related to the initial investment.

It is important to note that since the most likely value of the size of these delays are zero, they cannot be included in the deterministic DCF models as they only considers the most likely value of the input variables.

Table 7: Delay

	Min	Most Likely	Max	Distribution	Occurs
(A) Vessels	0 months	0 months	4 months	Triangular	Before operations
(B) Consents	0 months	0 months	4 months	Triangular	Before construction
(C) Inefficient Installation	0 months	0 months	4 months	Triangular	Before operations
Total	**0 months**	**0 months**	**12 months**		

Source: Own construction based on values from experts at DONG Energy

The causes for delay are represented in Table 7, as are their most likely, minimum and maximum values. For simulation purposes, the delays are assumed to be triangular distributed and occurs either before the construction phase or during the construction phase, before operations has commenced. Notice that the most likely values are zero, meaning that the projects are expected to proceed without any delays.

4.5.7. Correlations

The use of Monte Carlo simulation allows for the incorporation of correlations between inputs. This is very important to consider since it puts a restriction on the values the input variables can have. If one variable has been simulated to have a specific value, another with this correlated variable is then bound to have a value not violating the specified correlation. As an example, in this analysis, the correlated CAPEX inputs will have a value in relation to the simulated value of the affecting delay.

Table 8: CAPEX Correlated with Delays

	Correlated with	Downside Correlation
Resource Costs	Delay A and C	100 %
WTG Installation	Delay A and C	100 %
Installation of Foundations	Delay A and C	100 %
Installation of Array Cables	Delay A and C	100 %

Source: Own construction based on values from experts at DONG Energy

As mentioned in section 4.5.6, the realized values of certain investment costs are related to the occurrence of delays in the project before the operations phase. Due to these possible delays, the in Table 8 summarized capital expenditures, might increase towards their maximum values.

4.6. Output Variables

The chosen output variables are NPV and IRR. As mentioned, the choice of using these two valuation measures is based on how survey evidence states that these two measures are the most commonly used variables as investment criterions (see section 3.1.2 for further details).

The following segment of this thesis deals with the estimation the WACC. This is an extensive process and requires a large number of input estimates. Hence the following sections are devoted to the estimation procedure of the WACC.

4.7. Discount Rate

To discount the projects' estimated future cash flows correctly, the WACC has to be relevant and capture the systematic risk level of wind power investments by DONG Energy. In order to estimate the WACC, the *capital structure*, the *beta*, as well as the *return on equity* and *cost of debt* needs to be estimated. The necessary estimation procedure is designed to obtain the *market values*, rather than book values of these variables in order for the WACC to correspond to the current market situation as discussed in section 3.2 (Koller, et al., 2010; Brealey, et al., 2011; Titman & Martin, 2011). The process of performing the estimation of the project specific WACC and its inputs is described in Figure 13 and follows the procedure described in 3.2 and 3.3 above.

Figure 13: WACC Estimation Process

Source: Own construction

Moreover, the projects are financed of the company balance sheet and the debt capacities of both Project A and B are assumed to be similar to the overall company. As a result there is no need to estimate a separate capital structure for the projects, which is different from the overall company. If the risk level of the project on the other hand differed considerably from the company average, it would have been necessary to make adjustments of the debt capacities of the projects to estimate an appropriate WACC as previously discussed in section 3.3.3.

4.7.1. Net Debt

To obtain the market based capital structure used in the WACC calculations, the net debt of DONG Energy is estimated as the net of the interest bearing debt outstanding that requires a return to the debt holders. When estimating the net debt the *book value* of debt is used since it is common practice to use book values if most of the company debt is not effectively publicly traded, but rather stated in contracts with a known fixed cost (Titman & Martin, 2011; Petersen & Plenborg, 2012). This is also the case for DONG Energy were 82.4% of the interest payments are fixed (DONG Energy A/S, 2013b). The net debt is estimated according to Equation 17.

Net Debt = Interest Bearing Debt – (Cash + Cash Equivalents) **Equation 17**

Source: Petersen & Plenborg (2012)

The value of the net debt used in this case is based on the 2012 annual report were DONG Energy had interest bearing debt to a value of DKK 54,543 million and an estimated value of cash and cash equivalents of DKK 21,049 million (DONG Energy A/S, 2013a). Hence, the total net debt according to the annual report amounts to DKK 33,494 million as of 2012-12-31. However, the net debt reported by a company is not always categorized as net debt from an analytical purpose, where all interest bearing and debt-like capital should be considered as debt (Petersen & Plenborg, 2012). Relevant for this case is that DONG Energy has issued hybrid capital of DKK 9,538 million. Hybrid capital is often difficult to categorize and makes the estimation of the capital structure more cumbersome as the hybrid capital contains elements of both debt and equity. According to the accounting rule for compound financial instruments found in IAS 32[8] the hybrid capital is recognized as equity on the DONG Energy balance sheet. The reason behind the classification of the hybrid capital as equity depends on the debt obligation, which is set to nil as a result of the 1000-year term of the hybrid capital. However

[8] A definition of Hybrid capital and IAS 32 is found in Appendix 9:9.

for analytical purposes, the analyst should separate the hybrid capital into debt and equity if possible, according to (Koller, et al., 2010). While dividing the hybrid capital into a debt part and an equity part can be considered optimal approach, Petersen & Plenborg (2012) argue that if some source of capital requires fixed payments comparable to interest payment it is common practice to treat it as debt. Consistent with this, the choice has been made to treat the hybrid capital as debt since yearly coupon payments are settled, as with the outstanding DONG Energy corporate bonds. Though the coupon payments attributable to the hybrid capital can be deferred, DONG Energy has never deferred these, and if they are deferred, the accumulated hybrid coupons must be paid out before any dividend payouts to the shareholders are made (DONG Energy A/S, 2013b). This choice of treating the hybrid capital as debt is further motivated by Standard & Poor's having announced an updated global hybrid criteria as of 2 April 2013 were they stated that one of the two DONG Energy hybrid bonds likely will only qualify for "minimal" equity content, which is interpreted as 0 % compared to the 100 % attributable to the securities prior to the change in criteria (DONG Energy A/S, 2013b). The effect of treating the hybrid capital as debt is that the net debt is increased by DKK 9,538 million, to DKK 43,032 million.

4.7.2. Cost of Debt

Referring to the discussion in section 3.2.2, the appropriate cost of debt for project valuation is the *marginal* cost of debt. In DONG Energy's case the last issued corporate bond with a corresponding time horizon to the projects in this investment case has a yield to maturity (YTM) of 4.10 % before tax (see Table 9) and 3.075 %[9] after tax at the time of the project valuation.
Further the low yield to maturity reveals that the cost of debt is very low and that the yields to which the bonds are traded are below the coupon rate. This indicates that the cost debt that DONG Energy would have got at the time of the valuation if issued new bonds with a 20-year time to maturity would have been lower than before.

Table 9: YTM for the latest issued 20 years Bonds

Bond ID	Principal	Principal (EUR)[10]	Coupon	Maturity	Issued	YTM
XS0730243150	GBP 750 m	EUR 875.86 m	4.875 %	2032-01-12	2012-01-12	4.10 %

Source: Börse Frankfurt (2013)

[9] By applying the Danish marginal corporate income tax of 25 % (KPMG International Cooperative, 2013).
[10] EUR 1 = GBP 0.85630 (European Central Bank, 2013).

4.7.3. Market Value of Equity

Estimating the market value of equity (MVE) for privately held companies is not a straightforward process since there are no traded shares whose current price reflects value of equity according the market. One method commonly used to obtain the MVE for a non-publicly traded company is the *relative valuation approach*. This method relies on the relative pricing of what is known as *peer companies*, which are companies similar to the company whose equity is being valued. With this procedure, ratios or *multiples* for the publicly traded peer companies are used as benchmarks to estimate the implied current market price of the privately held company's stock, if it was publicly traded. Various multiples can be used to estimate the equity value directly, for example P/E (price-to-earnings), P/B (price-to-book) or Price-to-Free Cash Flow. Another set of multiples is known as enterprise-value-based as they derive the MVE indirectly from the estimated enterprise value (EV). Examples of these multiples that are commonly used are EV/NOPAT, EV/EBIT or EV/EBITDA. However, since it is often a cumbersome, and in some cases an impossible task to find a matching publicly traded company, it is common practice to increase the sample size and use an estimate based on an average of several peer companies. By expanding the peer group, these differences between individual peer companies and the company are intended to be averaged out (Petersen & Plenborg, 2012).

Based on the discussion regarding the estimation of the multiples, a peer group relevant for DONG Energy have been chosen, consisting of six carefully chosen European companies[11]. Further, when using more than a single peer company, it is important that the accounting principles are equal among all the companies within the peer group, whereas only companies that uses the IFRS accounting principles are used as comparable companies.

The Choice of Multiple

One of the most used multiples to estimate the EV is according to Titman & Martin (2011) and Koller, et al. (2010) the EV/EBITDA multiple. The estimated EV is afterwards used to calculate the implied MVE. The alternative multiples mentioned above were not considered in this study as DONG Energy showed negative EBIT and earnings per share (EPS) 2012. Estimating the MVE based on negative values would make ratios derived based on those multiples difficult to use, and the result would be misleading.

[11] A brief description of the peer companies is found in Appendix 7:7.

$$MVE = EV - \text{Net Debt} - \text{Minority Interest} \qquad \textbf{Equation 18}$$

Source: Koller, et al. (2010)

Enterprise Value

The EV, that is often used to derive a market based capital structure, is interpreted as the estimated market value of a firms invested capital (Petersen & Plenborg, 2012). Furthermore the EV is related to the WACC calculations as it represents the invested capital that requires a return. Considering the EV it is also important to note that the EV is not the same as the sum of assets or debt and equity on the firm's balance sheet. Rather, the enterprise value is considered to be a capital structure neutral measure reflecting the market value of the whole business, which makes the ratios derived from this value comparable between peers in an analytical sense (Titman & Martin, 2011). To estimate the EV and consequently the MVE, there are various approaches. The most used are the *present value approaches* and *relative valuation* (peer multiples) (Petersen & Plenborg, 2012). If using the present value approach, which is a more extensive alternative compared to relative valuation, a detailed reformulated pro forma financial statement of DONG Energy as well as growth ratios for the company must be estimated. In this case the choice to only to use the multiple approach has been made, as it does not requires a reformulation of the company's financial statement[12].

Estimation of the Enterprise value based on the EBITDA/EV multiple

The EBITDA multiple is, as discussed above, estimated based on European listed peer companies with a similar business structure as DONG Energy. The data used for estimating the EV/EBITDA multiple is collected from Thomson One[13] and is based on the last trailing twelve-month (TTM) as well as estimates based on consensus estimates for the following twelve months (FY1) as of 2013-04-23. Based on an average of the peer companies, the estimate for the last twelve months is 6.45 and for the next twelve-month period the estimate is 5.86, shown in the Table 10. The implication of the multiples is that the EV among the peer companies is on average 6.45 respective 5.86 times the EBITDA. In order to minimize the estimation error

[12] Reformulation the financial statements would be too extensive with respect to the focus of the thesis.
[13] For the definitions used by Thomson One regarding financial data, see Appendix 10:10.

in the EBITDA multiple, an average of the TTM and FY1 value was used. This gives an estimated EV/EBITDA multiple of 6.16 based on the chosen peer companies.

Equation 19 explains how averaging the ratio for *n* traded peer companies derives the EV/EBITDA multiple used in this case.

$$\text{EBITDA Multiple} = \sum_{i=1}^{n} \left(\frac{1}{n}\right) \frac{EV_i}{EBITDA_i}$$ **Equation 19**

Source: Koller, et al. (2010)

Table 10: DONG Energy Peer Group

DONG Energy Peers	EV/EBITDA TTM	EV/EBITDA FY1
EDF Energy	8.14	8.42
E.ON	5.54	4.06
Enel	7.10	5.89
Fortum Oyj	5.96	5.35
Iberdrola	6.66	6.86
RWE AG	5.27	4.57
Average	**6.45**	**5.86**

Source: Own construction based on data from Thomson One

Enterprise Value Estimates

The DONG Energy EBITDA level from the last annual report, if considering the IFRS standard as in the case with the peer companies, amounts to DKK 7,159 million (DONG Energy A/S, 2013a).

By using Equation 20 the estimated EV based on DONG Energy peers and 2012 years EBITDA for DONG Energy, amount to only DKK 44,100 million.

$$\text{EV}_\text{i} = \text{EBITDA}_\text{i} \times \text{EBITDA Multiple}$$ **Equation 20**

Source: Titman & Martin (2011)

The 2012 DONG Energy EBITDA level is DKK 8,436 million below that of 2011 (DKK 15,595 million). This substantial decrease depends to a large extent on the Energy Market business unit with a drop in EBITDA of DKK 6.6[14] billion and refers to a drop in provisions and losses within the gas business according to DONG Energy CEO, Henrik Poulsen (Poulsen, 2013). For valuation purpose, it is relevant to assess if this value is a reasonable level for the future DONG Energy EBITDA or if it should be adjusted to correspond to a relevant level. It is common when using EBITDA multiples to sometimes must adjusted these for nonrecurring events that are not likely to be repeated in the future (Titman & Martin, 2011). That is, an event that biases the estimate of the future earning power should be smoothed to get a more correct estimate.

In this case it can be discussed whether EBITDA should be adjusted or not for provisions of DKK 2.9 billion within the Energy Market business as well as the non-recurring income of DKK 1 billion. Consequently the analyst has to judge whether such provisions are occurring on a regular basis or if they should be considered as a non-recurring special event. Compared to EBITDA for previous years, the above mentioned events are of non-recurring nature whereby it is necessary to add back those amounts to the EBITDA to get a fair future level. This since the provisions depends on contracts for gas storage and terminal capacity (DONG Energy A/S, 2013a). In addition it is reasonable to do this adjustment since the EBITDA for the other four business units increased by DKK 1.5 billion from 2011 to 2012, which indicates a higher future earnings potential and consequently a higher enterprise value. As a result and in order to assess a reasonable EV estimates various adjusted EBITDA measures have been tested according to Table 11 below. The largest value (DKK 76.6 billion) was estimated when using the five-year average, including the 2012 value adjusted for the non-recurring costs previously discussed.

Table 11: Estimated Enterprise Values based on DONG Energy peers

	EBITDA			
DKK million	2012	2012 (Adj.)	2008-2012 (Average)	2008-2012 (Adj. Average)
EBITDA	7,159	11,532	11,861	12,435
Multiple	6.16	6.16	6.16	6.16
EV (Estimated)	**44,099**	**71,037**	**73,064**	**76,600**

Source: Own construction based on (DONG Energy A/S, 2013a)

The derivation of the current market value of equity for DONG Energy is estimated to be below the book value of DKK 33,421 million as of 2012-21-31, when based on this valuation approach. Naturally the different level of the EV is also reflected in the MVE since the level of

[14] The loss reflected provisions of DKK 2.9 billion, a non-recurring income of around 1 billion. The remainder reflects lower earnings from gas-fired power stations and a wider spread between oil and gas price (Poulsen, 2013).

net debt is fixed (see section 4.7.1). In the below Table 12 the respective market values of equity is derived based on the estimated EV and the assumption to classify the hybrid capital as debt.

Table 12: Market Values of Equity Based on DONG Energy Peers

	EBITDA			
DKK million	2012	2012 (Adj.)	2008-2012 (Average)	2008-2012 (Adj. Average)
EV	44,099	71,000	73,010	76,600
-Minority	-7,057	-7,057	-7,057	-7,057
-Hybrid	-9,538	-9,538	-9,538	-9,538
-NIBD	-33,494	33,494	33,494	33,494
MVE (Est.)	**-5,990**	**20,911**	**22,921**	**26,511**

Source: Own construction based on (DONG Energy A/S, 2013a)

The declared book value of owner's equity in the 2012 annual report is DKK 33,421 million, which deviates from the estimates in various degrees. Especially if considering the estimate solely based on the 2012 EBITDA level the estimated MVE is negative when based on the DONG Energy peers (DKK -5,990 million), which motivates an upward adjustment in EBITDA based on the previous discussion. Consequently, in order to minimize the estimation error in the EBITDA multiple only the MVE of DKK 22,921 million will be used, which is based on the five-year average EBITDA level. The choice of the average EBITDA level is further based on that the level of EBITDA has fluctuated during the last years whereby an average seems like a reasonable choice for our purpose of estimating a MVE to be used in the WACC calculations.

To sum up, it is important to note that this estimated market value is based on assumptions and judgment, and only based on one of many potential approaches for estimating the MVE. For example, the estimated MVE is dependent upon which of the estimated EV that is used and how the hybrid capital is treated. The EV does in turn depend on which multiple that is chosen, the EBITDA/EV multiple in this case, and which peer group that is used. Naturally it is therefore critical to evaluate the value of equity based on peers and one must keep in mind that the method is based on assumptions and that personal judgment gives different estimates.

4.7.4. Return on Equity

Estimating the return on equity based on the CAPM formula (see Equation 4) involves estimating the input parameters; the risk free rate (r_f), the market risk premium ($r_m - r_f$) and the levered beta for the project.

Risk Free Rate and Market Risk Premium

Estimating the market risk premium intends to reflect the risk of to the Danish market. An estimation was performed where the return of the Danish KAX Index was compared to the interest rate on 10-year Danish government bonds, which were used as an estimate of the risk free rate. The market risk premium was estimated to 5.89 % based on a regression of ten-year monthly data[15]. The risk free rate used was collected from international market rate statistics from Sveriges Riksbank and estimated at 1.486 % (Sveriges Riksbank, 2013). Further, the estimate was compared to other analyses and surveys to get an overall idea of the current consensus among investors and professionals. For example, in a survey undertaken by Fernandez (2013), the market risk premium was estimated to 5.50 % and correspondingly estimated to 5.10 % in the Credit Suisse Global Investment Returns Yearbook 2013 (Keating & Natella, 2013). Though these comparable estimates are somewhat lower than our estimation, they are in level with our estimation and thus we decided to use our estimation.

Project Beta

For evaluating the project systematic risk compared to the company's general risk levels both the company beta and a project specific beta for wind power investments is estimated based on two peer groups. The purpose for calculating the company beta is to compare the systematic risk within the wind power business to the systematic risk of the company as a whole. The first peer group consists of the peers to DONG Energy as the whole company, which was also used in the above calculations of the company capital structure (see section 4.7.3). The second peer group included companies that are comparable to wind power energy production in Europe. A description of the renewable energy sector peer companies is found in Appendix 6:.

The estimation of the beta is one of the most critical parts in the process of risk adjusting the discount rate to market risk. Furthermore it is the only factor in the CAPM formula that is company or project specific. To account for estimation errors, the mean values of the unlevered betas was used. These mean values were 0.4942 for the renewable energy peer group and 0.6692 for the DONG Energy peer group. The two beta estimates indicate that the systematic risk is lower for the renewable energy sector compared to the energy production sector in general.

[15] The calculation is based on data found in Appendix 5:5.

These estimates serves as a comparison when evaluating the overall risk level for the case projects, however in subsequent sections only the renewable energy beta will be used.

The beta estimation methodology applied is discussed in section 3.3.1. To instead undertake a subjective approach to estimate the beta was not considered as an option due to the absence of theoretical acceptance as mentioned in section 3.3.2. In order to unlever the beta values for the peer companies, Equation 8, which is presented again below, was used using net debt and market value of equity, estimated previously in this section

.

$$\beta_A = \frac{\beta_E + \beta_D (1-t)\frac{D}{E}}{1+(1-t)\frac{D}{E}}$$

The average beta values for both peer groups respectively is found in Table 13 and Table 14, respectively.

Table 13: Unlevered Beta Based on Renewable Peers

	β_E	D/E	β_A	T_C
Alerion	0.76	2.65	2.99337	31.40 % (IT)
EDP Renonváveis	1.07	0.71	0.72909	30.00 % (ES)
Enel Green Power	0.67	0.79	0.455335	31.40 % (IT)
Falck Renewables	0.72	2.02	0.324122	31.40 % (IT)
Fersa	0.82	1.22	0.473527	30.00 % (ES)
PNE Wind	0.32	0.79	0.272056	29.48 % (DE)
Theolia	1.64	1.65	0.90604	33.33 % (FR)
Average	**0.857**	**1.08**	**0.494**	

Source: Own construction based on data from Thomson One

Table 14: Unlevered Beta based on DONG Energy Peers

	β_E	D/E	β_A	T_C
EDF	0.88	1.40	0.660975	33.33% (FR)
E.ON	0.99	0.55	0.780209	29.48% (DE)
Enel	0.89	1.38	0.650886	33.40% (IT)
Fortum Oyj	0.67	0.74	0.524511	25.00% (FI)
Iberdrola	1.09	0.75	0.811056	30.00% (ES)
RWE	0.79	1.43	0.588355	29.48% (DE)
Average	**0.89**	**1.04**	**0.669255**	

Source: Own construction based on data from Thomson One

As previously discussed, the unlevered betas corresponds the operational risk attributable to the businesses in which the peer companies operate in. Thus the lower unlevered beta of the renewables indicates that the operational risk is lower for companies solely active within the renewable energy sector. There might be various reasons explaining the result but intuitive interpretation is that the revenues are safer from renewable energy sources due to for example government subsidies, which works as a hedge against movements in energy prices. Furthermore, electricity produced by renewable sources gain priority compared to other production methods in many of the European countries (see Appendix 8:8 for further details). This implies that power providers are often forced by law to buy all electricity produced by renewable sources and distribute it in the grid. Naturally, this aspect might also affect the relatively low level of operational risk despite the fact that the investment in fixed costs are large compared to operational costs, a factor that according to theory indicates a higher unlevered beta (Brealey, et al., 2011). Consequently, the subsidizing government bears a portion of the risk related to the investments. On the other hand, those companies might face more political risk in a sense since it might be difficult to predict the future level of subsidies. Italy has for example recently changed their system for subsidies to a lower level (see Appendix 8:8). Naturally, the level of political risk is thus affected by how the subsidy contracts are negotiated and for how long the production is backed up. However, since the beta values are based on historical values, primarily historical levels of subsidies might have affected the betas levels in this study. Still, some expectations of the future level might have imposed an effect on the level as well. This since the market capitalization values of the peers used when estimating the asset betas are affected by general expectations of the future, which most certainly also include expectations of future subsidies.

Further, in comparison to the beta based on DONG Energy peer companies, the renewable peer companies are to a larger extent solely exposed to the price of electric power while the beta based on DONG Energy competitors on the other hand are involved in various businesses and therefore exposed to other kinds of market risk. Still, both beta estimates are low which indicates that the operational risk, unaffected by company leverage, is low within the energy and power sector in general compared to the overall market. One reason might be that electricity cannot be stored and as it must be sold immediately its dependence of general market movements is also lower.

The Stern Business School professor Aswath Damodaran frequently updates industry beta values estimates. The last update was undertaken in January 2013 and betas for Power, Gas and electric utility sectors, Oil & Gas distribution and Natural gas sectors are presented in Table 15.

Table 15: Unlevered Industry Betas

Industry	β_A
Electric Utility[16]	0.34
Natural Gas	0.97
Oil & Gas Distribution	0.71
Power	0.53

Source: (Damodaran, 2013)

It is important to note that these unlevered industry values includes companies engaged in various sources of renewable power generation but also companies involved in power generation by different sources. Further, there are no sector beta available for renewable energy production but the Power sector is the industry closest to the renewable energy sector and the Power beta of 0.53 corresponds fairly well to the calculated renewable energy production beta of 0.49.

In conclusion, the unlevered beta estimates have been made according to theory an estimate of the systematic risk in the industry unaffected by capital structure (see section 3.2.3). However, since the total risk is a combination of operating and financial risk it is required to relever the asset beta to account for the financial structure of DONG Energy. The relevered beta was calculated according to Equation 9 shown again below using net debt and the market value of equity.

$$\beta_E = \beta_A\left[1 + (1+t)\frac{E}{D}\right] - \beta_D(1-t)\frac{D}{E}$$

By using the already estimated market value of equity of DKK 22,714 million and net debt of DKK 43,032 million, the levered project beta was estimated to 1.19012 (see Appendix 1:1 for details about calculation). This value is based on the assumption that the beta of debt is zero, since the cost of debt is assumed not to vary with market fluctuations (see section 3.2.2). The

[16] The Electric Utility Industry was originally presented by a geographical breakdown (East, West and Central). The figures found in this study are instead based on an average of the three areas.

result indicates that an investor can expect fluctuations in the return on equity that is slightly above the fluctuations of the market in general. By comparing the levered renewable energy sector beta (0.49) to the corresponding unlevered beta (1.19), it is possible to conclude that the capital structure of DONG Energy accounts for the greater fraction of systematic risk attributable to the project. The estimated beta value is consequently based on a market value based capital structure of DONG Energy with a D/E ratio of 1.88. This D/E ratio is larger compared to the industry averages presented in Table 16. The large value of the ratio is much dependent upon the assumption to classify the hybrid capital as debt since the net debt increases by DKK 9,538 million and thus makes up for 22 % of the debt. Naturally, if the hybrid capital was treated as equity as it is on the DONG Energy balance sheet, which in this case would lower the D/E ratio for DONG Energy to 0.97. This significant difference indicates that personal judgments and assumption imposes serious effects on the estimated results. Further, for comparison, the D/E ratios for the DONG Energy peer group is found in in Table 14. These values vary in the range between 0.55 and 1.43, indicating a large variation in capital structure between the companies in the peer group.

Table 16: Industry Average D/E Ratios

Industry	Market *D/E*
Electric Utility	0.78
Natural Gas	0.41
Oil & Gas Distribution	0.53
Power	1.63

Source: (Damodaran, 2013)

Cost of Equity according to CAPM

Based on the method of using the EBITDA/EV multiple and the assumptions discussed in the previous sections, the required return by equity investors for investing in wind power is estimated to 8.496 % (see Appendix 1:1 for details about the calculation) according to CAPM (see Equation 4).

4.7.5. WACC

As all the necessary inputs have been estimated *(value of debt, cost of debt, market value of equity* and *return on equity)* it is possible to estimate the weighted average cost of capital for wind power investments undertaken by DONG Energy. Based on the input estimates, the

WACC (see Equation 2) for wind power investments is estimated at 4.96 % (see Appendix 1:1 for details about the calculation).

The unlevered beta estimate for renewables energy production was estimated to be lower than the beta based on DONG Energy peers (5.82 %)[17], which consequently implies that this WACC, specific for wind power investments is lower than the average DONG Energy company WACC.

In conclusion the market based DONG Energy capital structure is mainly characterized by debt finance at the moment, which is also seen when comparing the net debt (excluding hybrid capital). The net debt has increased from DKK 23,615 million in 2011 to DKK 33,494 million in 2012, which correspond an increase of about 40 %. This increased level of net debt in combination with the classification of the hybrid capital as debt and the poor 2012 result with a low EBITDA level, can thus explain the current market based capital structure of DONG Energy.

4.8. Deterministic DCF Valuation

To perform the deterministic DCF valuation of the case projects, the financial valuation model has been constructed to calculate NPV and IRR for both projects based on the estimated most likely values outlined in section 4.5 and the WACC described in section 4.7 above. The DCF models uses yearly periods and the specific model used for valuing Project A[18] can be found in Appendix 2:. The input variables are entered as yearly values, for example the operational expenditures are entered at their total amount for a whole year and resulting free cash flows are then calculated on a yearly basis. The FCF refers to PFCF since the projects are financed by the company balance sheet and no specific debt is attributable to the projects (see section 3.3.3).

4.8.1. Deterministic DCF Analysis

The deterministic model is set up in such a way that when having entered all the necessary input parameters, the model displays the calculated values for the output estimates, NPV and IRR. If a variable is changed, the resulting output variables will instantly change accordingly.

[17] See Appendix 1:1 for details about the calculation

[18] The Project B model is excluded in the appendix as it merely differs in the certain figures used from Project A.

The result of conducting the deterministic DCF valuation is to calculate the most likely NPV and IRR for the project. This is achieved through using the most likely values for the input variables throughout the whole model. The resulting output values are therefore the most likely project values and this can be considered the most likely case to occur.

In the deterministic DCF model the resulting outputs are presented as static values of the chosen output variables, NPV and IRR. These values are summarized in Table 17.

Table 17: DCF Valuation Results

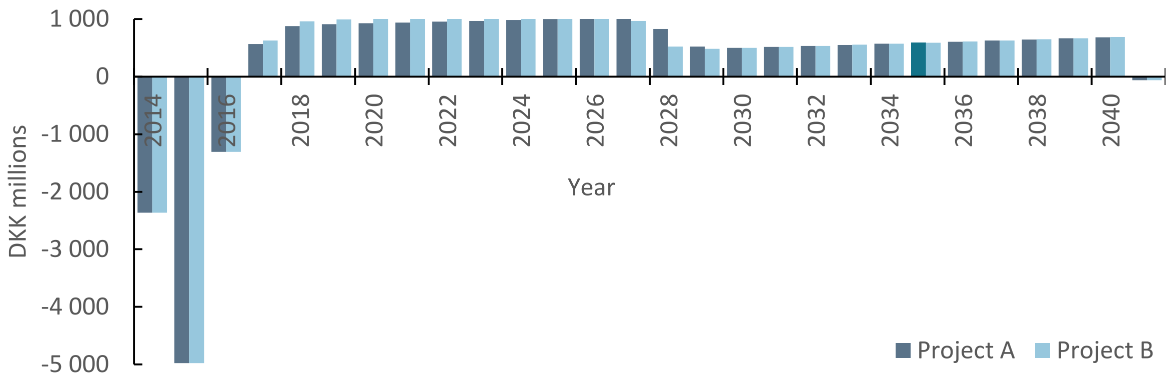
	Project A	Project B
NPV	DKK 1,566 million	DKK 1,967 million
IRR	6.76 %	7.26 %

Source: Own construction

Project A is estimated to have a NPV of DKK 1 566 million and corresponding value for Project B is DKK1 967 million. The rate at which the cash flows are generated, measured as the IRR is estimated to be 6.76 % for Project A, compared to 7.26 % when analyzing Project B. These results essentially confirms the same thing, namely that Project B is the best choice if deciding between to two potential investment opportunities according both the NPV rule and IRR. Both projects are according to both the NPV rule and the IRR rule to be carried out since the NPV is larger than zero for both projects and the IRR is larger than the opportunity cost of capital represented by the WACC at 4.89 %. However, the projects are mutually exclusive and cannot be carried out parallel to each other and therefore Project B is the investment to be made based on these NPV and IRR figures.

As these figures are a consequence of the forecasted future free cash flows, these are shown in Figure 14. From this it can be seen that the two projects have the same estimated investment cost, attributable to the first three years, but the preceding cash flows are estimated to be larger for project B. Also, the apparent decrease in cash flow levels for both projects around year 2028 is a result of the subsidies expected to end at that time.

Figure 14: Comparison of Forecasted Cash Flow



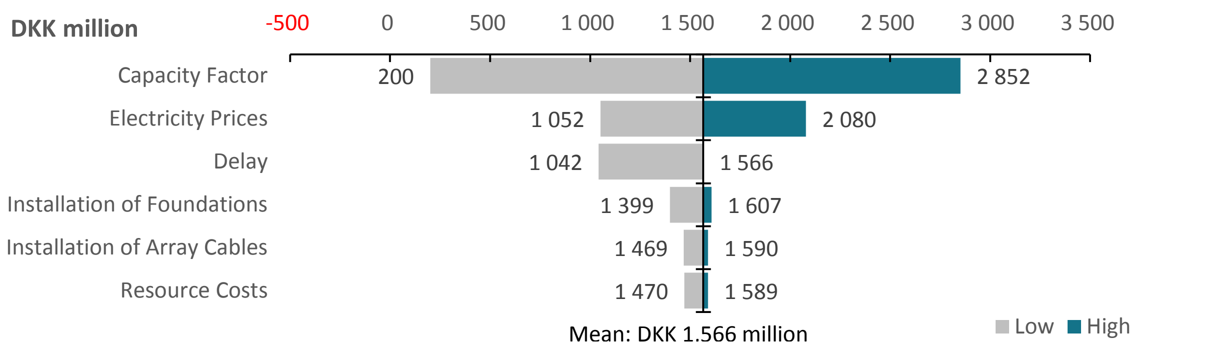
Source: Own construction

4.8.2. Sensitivity analysis

To evaluate which input variables that have the largest and most significant impact on the project value (NPV and IRR) a sensitivity analysis was performed on both case projects. This was in practice carried out by keeping everything else static while setting one input variable at a time to its smallest value (denoted "Min" and "Max" in the input variable tables in section 4.5), saving the resulting project NPV and IRR, as well as changing the variable to its largest possible value. The process was repeated for each uncertain project input variable for both projects.

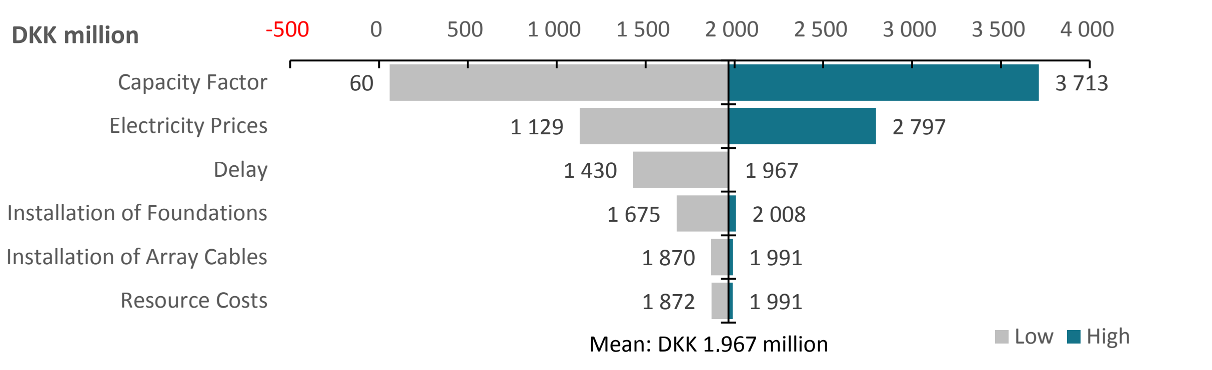
Below, the results from the sensitivity analysis are summarized graphically in "tornado charts" and are presented for Project A and Project B in Figure 15 and Figure 16 regarding the NPV, and in Figure 17 and Figure 18 for the IRR. This graphical representation features the six input variables with the largest impact on the given output variable, organized from largest to smallest impact. Input variables with a smaller impact on the output values have been excluded due to their, in comparison insignificant effect on the NPV and IRR of the two projects. The charts illustrate how varying the input variable individually between its smallest and largest possible value affects the total output.

Figure 15: Sensitivity Analysis of NPV, Project A



Source: Own construction

Figure 16: Sensitivity Analysis of NPV, Project B



Source: Own construction

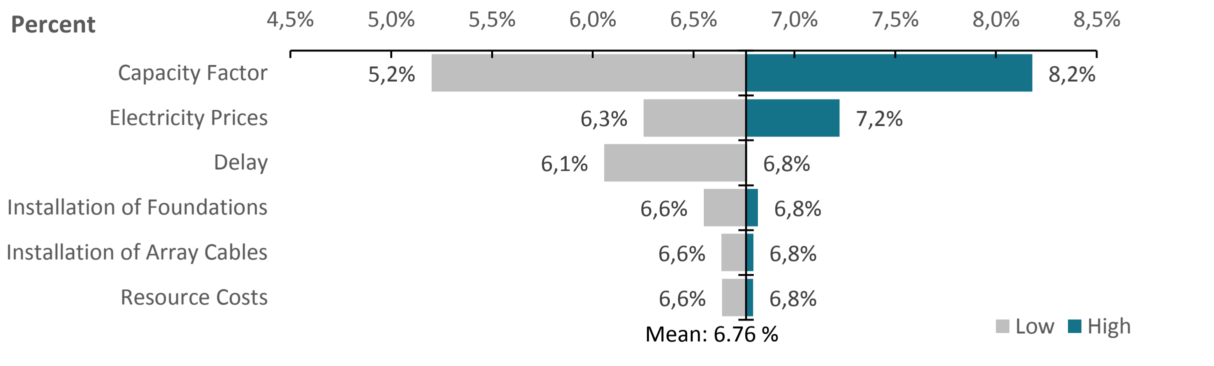
From Figure 15, representing the sensitivity analysis of NPV of Project A, it is very clear that deviations from the most likely value of the capacity factor is the number one most import source of uncertainty in the NPV. This is followed by the effect of potential fluctuations in the electricity price. The variable with third most effect on NPV is the delays before construction and operation begins, a variable that affects the start date of operations and with this, postponing the actual income from the project. As seen in section 4.5.7 above, the delays are correlated with certain capital expenditures, meaning that the size of these expenditures will be affected by the delays. However, such relationships are difficult to model correctly in a deterministic model and have thus been excluded from this sensitivity analysis. The three last included variables with most significant impact on NPV are all different capital expenditures and relates to the installation of the foundations, the installation of array cables and lastly resource costs.

Figure 16 above in turn, illustrating the input variables effect on NPV for Project B, essentially shows the same conclusion; the capacity factor has the by far largest impact on the NPV, followed by the electricity price, the delay and the lastly the same capital expenditures. This is a far from surprising result as the two projects valued are in most aspects identical. However the size of the effects of the input variables vary between the two analyses. Differences in the revenue related inputs of capacity factor, electricity price and the delay to some extent, is related to Project B having a larger estimated production. Hence changes in input variable connected to the production tend to be amplified and the resulting NPV varies in a larger range. Changes in the capital expenditures affect the NPV equally for both projects with the exception for the installation of the foundations, as this variable has a larger maximum possible value for Project B. The similarities however are a result of the capital expenditures being determined by the size of the wind farm, which is the same for both Project A and Project B.

Lastly, it should be noted that the delay only have inherent uncertainties that will decrease the projects values, the variable cannot, according to its estimation, have a value smaller than the most likely, since this value is zero. There are no modelled possibility that the investment phase will be finished in less time than the most likely estimate, which would have been corresponding to a "negative delay".

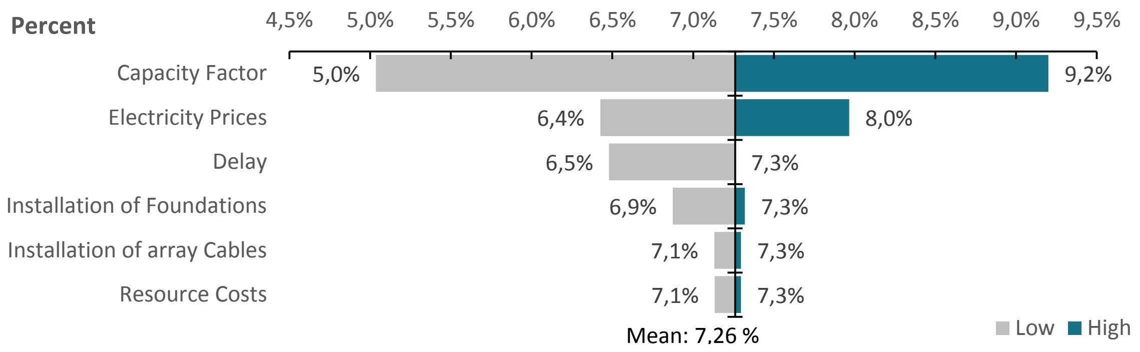
Not surprisingly, since the measurements of NPV and IRR are closely related (see section 3.1.2), the sensitivity analysis of IRR indicates that the same variables have the most significant effect on the IRR, seen in Figure 17 and Figure 18.

Figure 17: Sensitivity Analysis of IRR, Project A



Source: Own construction

Figure 18: Sensitivity Analysis of IRR, Project B



Source: Own construction

The discussion above regarding the differences and similarities between the two projects in terms of the input variables' effect on NPV can also be applied to the sensitivity analysis of the IRR. The variations in revenue-related variables affect the IRR more for Project B and the capital expenditures have a similar effect on the IRR, with the exclusion of the cost for installing the foundations as this variable has a potentially larger maximum value in Project B.

4.8.3. Scenario Analysis

The most basic case for the scenario analysis is to calculate the NPV and IRR by using the worst possible values for the model parameters, resulting in a "worst case", and the best possible values, making the output the "best case". While neither of these cases are likely to occur, combining these with the most likely provides a range of possible outputs. The results from the scenario analysis are summarized in Table 18 for Project A and in Table 19 for Project B.

Table 18: Results Project A

	NPV	IRR
Best	DKK 5,217 million	10.42 %
Most Likely	DKK 1,566 million	6.76 %
Worst	DKK - 2,682 million	1.94 %

Source: Own construction

Table 19: Results Project B

	NPV	IRR
Best	DKK 7,222 million	12.28 %
Most Likely	DKK 1,967 million	7.26 %
Worst	DKK - 3,619 million	0.80 %

Source: Own construction

As shown above, the range of possible values for both NPV and IRR are far larger for Project B. The worst-case scenario results in a NPV of DKK -2 682 million and an IRR of 1.94 % for Project A, compared to the corresponding values of DKK -3 619 million and 0.80 % for Project B. While this potential downside is larger for Project B, examining the best-case scenario reveals an important aspect. The best case results in a NPV of DKK 7 222 million and an IRR of 12.28 % for Project B, but only NPV of DKK 5 217 million and an IRR of 10.42 % for Project A. While it can be concluded that investing in Project B poses a larger downside risk, such an investment also includes a larger potential upside in comparison to investing in Project A.

4.9. Monte Carlo Simulation in the DCF Model

The deterministic DCF models presented in section 4.8 and shown in Appendix 2:2 is also the foundations for the Monte Carlo simulation analysis presented in this section. The models are extended with the specific simulation process outlined in section 4.9.1 and the results of the simulation analysis is presented in the subsequent section 4.9.2.

4.9.1. Performing the Monte Carlo Simulation Analysis

Since the actual performing of the Monte Carlo analysis is based on a work process rather different in several aspects compared to the one for the basic deterministic DCF analysis, the details of this process have been divided for the two projects into five different steps.

Figure 19: Simulation Process

Source: Own construction

As Figure 19 illustrates, these steps involve the initial setup of the basic valuation model, the process of defining the input probabilities, the inclusion of correlated input variables, defining witch output variables to be generated and lastly the actual simulation process of the model.

The model outputs are not generated automatically, but are instead simulated with the aid from the specialized Excel add-in software "*@Risk*" by Palisades[19]. The output is generated through the simulation process and in comparison to the deterministic DCF model, the output values

[19] While there are similar software packages available, this specific choice was made due to DONG Energy using it themselves and also that Palisades could provide a "student version" at a discounted price.

(NPV and IRR) are, as the input variables, presented as statistical distributions rather than static values. The process of performing a deterministic DCF analysis, extending the valuation with both a sensitivity and scenario analysis and ultimately performing a valuation with Monte Carlo simulation is repeated for both investment cases making a clear side-by-side comparison possible.

Step 1: Setup Basic Model

For the two investment cases, the models that were developed for the deterministic DCF analysis in section 4.8 above is used as foundations for the Monte Carlo analysis.

Step 2: Defining Input Probability Distributions

In addition to these values, the minimum and maximum values or the standard deviations found in section 4.5 are used to define the input variables. As the probability-based input variables modeled are defined as either triangular distributions or normal distribution in this case the model has to be able to handle these. In the case of triangular distributions consisting of three-point estimates of the given variable, like many of the capital and operational expenditures, in addition to the already defined most likely value, the minimum and maximum values must also be specified. Considering the normal distributed input variables such as the capacity factor and some expenditures, the mean of the distribution is set as the most likely value used in the deterministic analysis and in addition to this, the estimated standard deviation is also specified.

In addition to defining the input distribution parameters, the type of probability distribution has also to be defined in the simulation software in order for the software to correctly treat the probability distribution parameters when performing the actual simulation.

Step 3: Defining Correlations

In the two analyzed projects, correlation factors are incorporated between the three reasons for delay and capital expenditure items *resource cost* and *installation of WTGs*, *installation of array cables* and *installation of foundations* (see section 4.5.7). Though the possible delays are not direct value drivers themselves, a delay during the construction phase will not only postpone operations and the revenue stream, but also increase the size of the in section 4.5.7 mentioned expenditures.

The correlated variables are specified in the simulation software together with the size and properties of the correlations. When simulation is run by the simulation software, the model will then automatically adjust the values of these correlated capital expenditures according to the simulated length of the delay in construction.

Step 4: Defining Output Variables

The chosen output variables for the simulation analysis are NPV and IRR as in the case of the deterministic DCF models (see section 4.6). Since these models are used as the base for the simulation, defining these output variables as output in the simulation analysis is reasonable for being able to make an appropriate comparison between the deterministic and the simulated DCF models. By instructing the software that these calculations are the desired output variables, @Risk will sample the outcome for these variables for each iteration performed during the simulation.

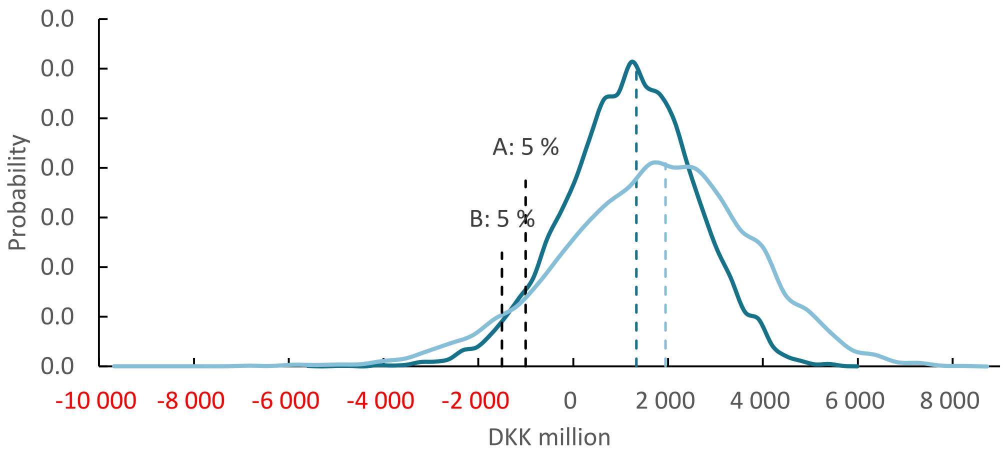
Step 5: Simulate Model

For each project used 10,000 iterations (or simulation runs) was used to perform the Monte Carlo analysis. This is the maximum number of iterations allowed by the software and the decision to not use a smaller number of iterations is due to the risk of the results being inconclusive due to too small sample. In practice, this means manual telling the software that this number of simulation runs is to be performed.

4.9.2. Monte Carlo Simulation Results

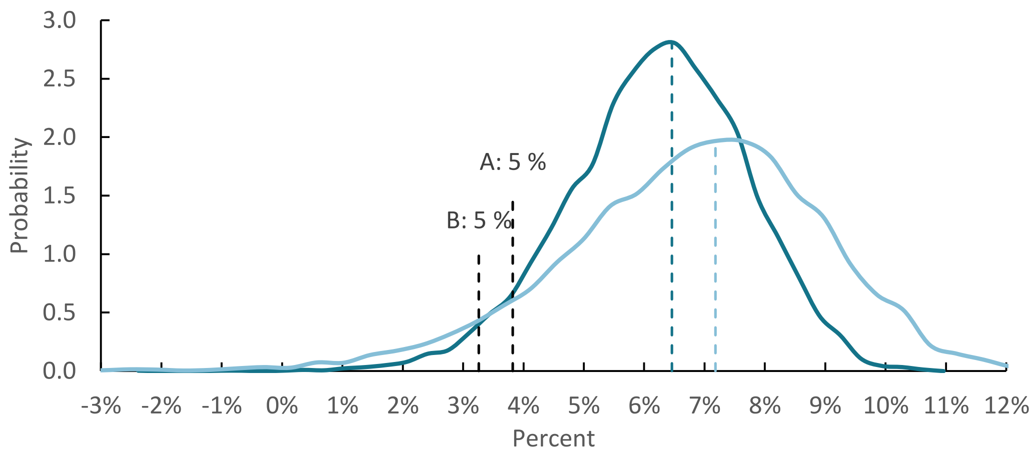
The generated outputs for NPV and IRR from the Monte Carlo simulation iterations are presented as probability distributions due to the defined uncertainties of the input variables. By graphing the probability distributions for the outputs for both potential projects in the same graph, a useful comparison can be made.

Figure 20: Comparison of Simulated Project NPV



Source: Own construction

Figure 21: Comparison of Simulated Project IRR



Source: Own construction

Figure 20 and Figure 21 essentially shows the same pattern, that the distributions for the output values for Project B are centered on a larger value than for Project A. However, due to the larger uncertainties incorporated in the Project B's input variable values, it has a possibility of having values both smaller than Project A, as well as larger.

Statistics (summarized in Appendix 11:11) from the simulation output show that the minimum and maximum values for NPV and IRR are larger for Project B than for Project A, meaning that the range of possible values are larger for Project B. This means that it is possible to realize a smaller value, in this case even a loss, if choosing Project B to be constructed. However with a larger maximum value, Project B also comes with possibilities of realizing larger values than Project A is estimated to be able to. Further, the above comparison charts reveal that the output probability distributions are centered around most likely values similar to the ones estimated in the deterministic DCF model. This is very reasonable as the most likely values used in the simulations corresponds to the static values used in the deterministic valuation. As these values have the highest probability to occur when performing the simulation, these values will also lead to similar most likely output values.

The statistics also reveals that the 5 % percentile for the NPV of Project A is approximately DKK -1 002 million. This means that according to the simulated model, Project A has a 95 % chance of having a realized NPV that is larger than this value. The corresponding number is 3.82 % for the IRR. The 5 % percentile values for Project B is approximately a NPV of DKK -1 501 million and an IRR of 3.26 % Using Project A as a starting point, this discussion can be extended by investigating which percentile the 5 % percentile values for Project A's NPV and IRR corresponds to for Project B. The 5 % percentile value for Project A of is found in the 7.6 % percentile for Project B. Regarding NPV, the 5 % percentile value for Project A corresponds to the 7.4 % percentile when turning to Project B.

The interpretation that Project B is subjected to more project specific risks due to the more uncertainties is also supported by the standard deviation for NPV and IRR being larger for Project B than for Project A.

Relating to the NPV rule as an investment criterion (section 3.1.2), both projects have an approximate probability of 84 % for having a NPV of zero or above. According to the NPV rule, a company should undertake any investment with an estimated NPV above zero as these investments are considered to be profitable. As the projects in this case study are mutually exclusive and cannot be performed parallel to each other, it can be concluded that both projects have the same probability of meeting this investment criterion and can be considered equal in this aspect.

From the result of the simulation analysis it can be concluded that Project B can be considered more interesting than Project A, with regards to Project B having a larger most likely NPV and IRR compared to Project A, as well as offering larger maximum possible values for NPV and IRR. However, Project B is also a more risky investment compared to Project A as the downside risk of realizing a NPV and IRR smaller than the most likely value might, according to the simulation analysis, result in values less than the corresponding values for Project A. It should be noted though, that while the value of Project B has more uncertainty in terms of risk, it also features a larger upside compared to Project A, meaning that there are larger potential gains above the most likely value if choosing to invest in Project B rather than Project A.

5. Discussions of Findings

This chapter is focused on discussing the different traits of including Monte Carlo simulation in DCF valuation. The case study performed in the preceding chapter 4 functions as a foundation for this discussion. Further, the discussion is supported by the interviews conducted with persons involved in the valuation process at DONG Energy, as these interviews have revealed additional aspects of the effects of introducing the simulation based valuation method.

5.1. Systematic Risk in Project Valuation

Using CAPM in combination with the classic DCF model in order to calculate the NPV of a proposed investment is one of the most used combinations within capital budgeting according to previous survey based research presented in section 1.5.2. There are however certain problems in practice when the CAPM methodology is applied to non-publicly traded ventures such as investment projects. Specifically, it is challenging to assess a relevant and a market based capital structure and a relevant beta value in order to include an appropriate level of systematic risk when evaluating a specific investment.

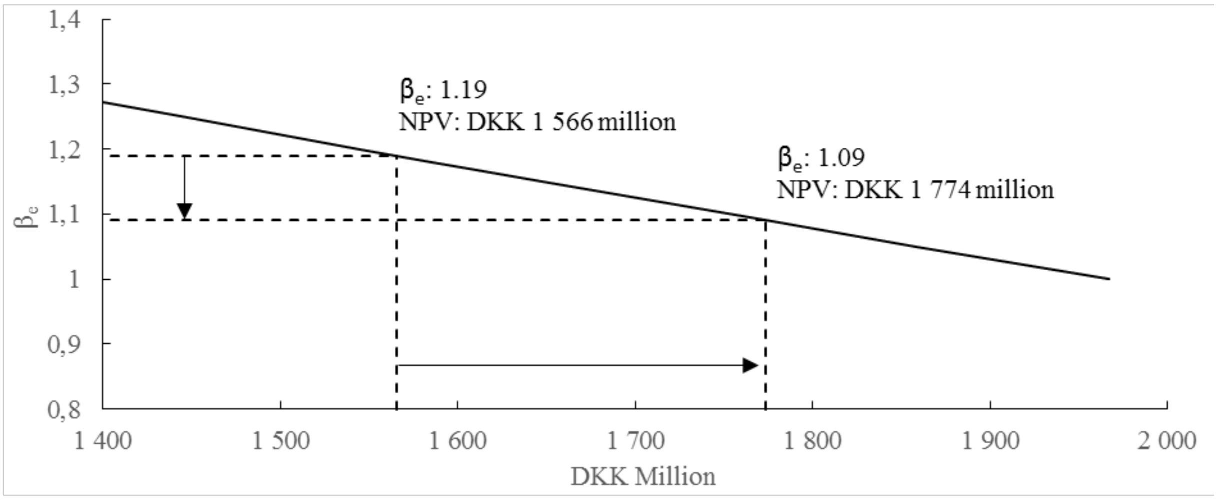
The method for estimating beta that is best aligned with the theory in this study is the method described in section 3.3.1. This approach is based on finding publicly traded peer companies that share the same risk profile as the project that is being valued and estimate an unlevered beta based on these companies. The estimated beta value is afterwards relevered to match the financial structure of the own project, in this case the financial structure for DONG Energy as the projects are assumed to be balance sheet financed (see section 4.7). The methodology was applied when valuing the potential offshore DONG Energy wind farms known as Project A and Project B in the case study presented in chapter 4.

Further, regarding the beta estimation related to the two case projects, revenues would be generated from sales of produced renewable electricity on the same geographical market, independently of which wind farm that would be constructed. According to CAPM, using the same beta when calculating the discount rate for both projects must therefore be considered as consistent with theory. Consequently the same beta of 0.49 was applied when estimating the cost of equity for both project A and B since the difference in risk profiles were related solely to project specific risks, all according to how CAPM divides risk into systematic and non-systematic. Therefore, the difference in risks attributable to the two projects concerned the uncertainties related to construction costs and production, all due to site-specific circumstances, but not to market-specific circumstances.

The procedure of calculating the beta for the projects was based on two different peer groups. The first peer group was used to estimate an unlevered beta for the projects, which was calculated, based on peer companies within the renewable energy sector (see section 4.7.3). The second group consisted of peer companies to DONG Energy, and was used to relever the unlevered beta. The followed procedure for beta estimation hence consists of several steps when the peer companies' betas were unlevered and relevered, and when the market based capital structure of DONG Energy was estimated since the projects were assumed to be balance sheet financed. The amount of assumption and choices therefore imply that this procedure, even though it is aligned with what theory suggests, is affected by subjectivity. A different choice of peer companies and classification of the debt and equity ratio would thus most likely have generated a different beta value, as well as a different estimated capital structure of DONG Energy.

Nevertheless, the unlevered beta can serve as a guidance of the systematic risk in the wind power industry and the relevered beta as a guidance of what the capital structure of DONG Energy implicate for the cost of capital estimate. Despite the shortcomings of the estimation procedure, the unlevered beta serves as an indicator of the risk in the wind power industry. This could be compared to the estimated unlevered DONG Energy beta that was estimated at 0.67 (compared to 0.49 for the renewable energy sector) (see section 4.7.4). The choice of beta, and the resulting WACC can have a very large impact on the estimated project value. This is illustrated in Figure 22, which shows the relationship between the estimated, in this case levered beta, and the NPV for Project A. Also, in Figure 22, the effects of a 0.1 decrease in levered beta is shown as an increase in NPV with DKK 208 million to DKK 1 774 million. Consequently, if the beta had not been adjusted to the wind power industry and instead been using the DONG Energy beta (estimated in section 4.7.4) it would have changed the project NPV significantly. This indicates the importance of estimate the beta in order to capture the appropriate systematic project risk.

Figure 22: Beta Sensitivity



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5.2. Non-systematic Risk in Project Valuation

Incorporating non-systematic risk in the deterministic DCF model should be done by weighting different cash flow estimates according to the probability of them to occur in order to obtain what is defined as unbiased cash flow estimates. However, previous research confirms that it is common practice that firms instead apply subjective adjustments to the discount rate in order to compensate for project specific risk. The previous studies presented in section 3.3.2 could confirm that firms on average add premiums in the range of 4 % to 5 % to the discount rate used when valuing investment projects, despite that the companies used CAPM to calculate the systematic risk. This implies that the estimated NPV is decreased and that a safety margin is included in the valuation, which consequently implies a biased valuation result. However in situations like this when companies are willing to adjust the discount rate, they could equally well decrease the discount rate correspondingly if the uncertainties relates to the estimated valuation inputs having a possibility of being more optimistic than expected.

Regardless of which adjustments that are made to the discount rate, this procedure of adjusting the discount rate increases in complexity as new factors are considered when the forecaster attempts to allocate different premiums to various perceived sources of uncertainty or risk, in order to adjust the discount rate to account for these factors.

As mentioned in section 2.4, the research methodology used in this thesis is, in addition to the case study, also supported by two interviews. During these interviews, Emelie Zakrisson disclosed that it is not uncommon that the input givers estimate values conservatively in order to compensate for uncertainties in the value. Related to the assumption that the cash flows are supposed to be unbiased, using cautiously estimated input values result in a valuation output that is lower than the true most likely value.

The above discussions leads to two implications. The first being that when estimating the discount rate as the WACC, the only included risk factor is found in the cost of equity if assuming that the cost of debt is regulated in contracts (see section 3.3.1). As it is common practice to use CAPM to assess the cost of equity, the systematic risk should be included in the beta value. The beta value in turn should only reflect market specific risk according to CAPM and adjusting this value to include diversifiable risk is inconsistent with theory as this risk is diversifiable by investors. The approach of adding a premium directly to the discount rate relies only on subjectivity and personal judgment. Therefore the estimated discount rate is likely to be biased as it potentially may contain several assumptions about risk factors that under this approach would be embedded in the discount rate. Secondly, adjusting the discount rate or directly adjusting the cash flows through the input estimates have one major drawback in common. These approaches of adjusting the project value according to the project specific risk level do indeed make it possible to include non-systematic risk in the valuation. However, the output in terms of for example NPV will say nothing about the lower value being a result of the actual cash flow being estimated as low, or if they are discounted or adjusted to the low values as a result of included project risk. As a result, the valuation output lacks transparency in terms of non-systematic risk. In a real life decision making process identifying the project specific risk to be able to assess and manage it can be crucial for a project's success.

Applying the above discussion to this case study, using a higher discount rate estimate or adjusting the input estimates when valuing the more risky Project B in order to compensate for increased project specific risk might have been motivated. Adjusting the discount rate in this case would imply that a higher cost of capital would be used to value Project B. As the cost of debt is assumed to be fixed, this would suggest that the cost of equity is higher, which would not be justified since the cost of equity is derived from CAPM. According to CAPM the only measure of risk is the beta, which should never include non-systematic risk. Further, as pointed out above, the beta value in the case study is motivated to be equal for both projects since the systematic risk from the market is the same independently of which wind farm that is constructed. Hence, adjusting the beta value directly or the overall discount rate for that matter is not motivated and implies that risk is not correctly classified and included in the valuation. To conclude, adjusting the discount rate or the input estimates by including non-systematic risk would decrease the forecasted cash flows and the project value. Nevertheless, both approaches would include the project specific risk but hide information about this risk in the project value and it would be impossible to separate and display different sources of risks.

5.3. Dealing with Non-systematic Risk in Deterministic DCF Framework

Relating to the problems discussed in section 5.2 above, including non-systematic risk in the deterministic DCF model results in that the static outcome of the valuation only can take the form of downward adjustments of the calculated project value. Consequently, thoroughly dealing with project specific non-systematic risk within the deterministic DCF model relates to also *assessing* the risk, rather than simply *including* it in the project value estimates. Assessing the non-systematic risk related to a project can be done in several ways. As described in chapter 2, two of the most common methods for gaging the risk level related to the valuation of a project is by conducting a sensitivity analysis and a scenario analysis.

5.3.1. Sensitivity Analysis

Performing a sensitivity analysis on the input variables in the DCF model intends to identify the input variables whose variability in their estimates has the largest effect on the resulting project value (see section 4.8.2). Hence, the sensitivity analysis does not include the risk in the project value, but evaluate how the realized project value might deviate from the most likely outcome due to the specific input estimates deviating from their most likely values.

In this case study the conducted sensitivity analysis revealed that the factors that affected the resulting project NPV and IRR the most due to the uncertainties of their estimates were the capacity factor, the delay, the electricity price, the installation of foundations, the installation of array cables and resource cost for both projects as shown in Figure 15, Figure 16, Figure 17 and Figure 18. With these important risk factors identified, it is possible to concentrate resources for managing these. However, the sensitivity analysis only assess the impact of the input variables one by one, whereby it does not tell anything about what the effects on the project value would be if more than one factor deviates from the most likely value. In addition to this, the sensitivity analysis does not reveal the probability for these deviations to occur, which is a very important shortcoming of the sensitivity analysis. The performed sensitivity analysis in the case study identified the key value drivers and their possible effects on project value. However, since the input variables in the case study are in reality assumed to be either triangular or normal distributed, the effects on project value identified by the sensitivity analysis does not in fact have equal probabilities due to the different underlying distributions. For example, according to the properties of the triangular distribution, approaching the minimum value means approaching a probability of zero. In the sensitivity analysis however, only the effects on project value when approaching the minimum value for the input variable is shown, but not that this value has an almost zero probability. If the underlying probability distributions are not known for the input variable estimates when performing the sensitivity analysis, this analysis cannot reveal this either.

To sum up, the sensitivity analysis only considers the range of the possible values of the input whereas it does not include any information about the different probabilities within. Also the practice of only evaluating the changes in project vale related to a single variable at the time makes the sensitivity only practical to use for identifying key value drivers, not for calculating possible project values.

5.3.2. Scenario Analysis

The aim with the scenario analysis is to identify a set of possible key scenarios and value the project according to these (see section 4.8.3). The three common general scenarios which was chosen to be used for this analysis is the worst case, the best case and the most likely case, though the scenario analysis can include any possible scenarios that are considered important to evaluate. In accordance with their names, the worst case and the best case refers to the absolute boundaries in between which the project value may lay, the most likely case is as its name suggest the most probable scenario, and therefore synonymous to the standard valuation case where unbiased estimates are assumed.

In the case analysis, the three included above-mentioned scenarios of best, worst and most likely case when performing the scenario analysis. The best case and the worst case provide the restrictions for the possible realized project values. Looking at the results from the case analysis, the NPV for Project A was estimated to be in the range of DKK -2 682 million to DKK 5 217 million, with a most likely value of DKK 1 566 million. For Project B the corresponding minimum and maximum values were estimated as DKK -3 619 million and DKK 7 222 million with a most likely value of DKK 1 965 million. Consequently the only information revealed is that Project B could get a higher best case and a lower worst case scenario than Project A.

A problem with the usage of the two extreme scenarios referred to as best and worst case is that, while the possible project value range is identified, in general neither has any realistic probability to occur. Relating to our case analysis, this would mean that all costs will be at their maximum value over the projects' lifetimes, together with the electricity prices as well as the wind being that their minimum value until the valuation horizon.

In addition, regardless of how the scenarios are defined, it is difficult to take into account correlations between input variables. This refers to variables whose values are fully or partially dependent on each other. In the performed case analysis this was exemplified with the potential delays before operation could begin. If any delay would occur, specific investment costs would rise such as for example the installation of array cables (see section 4.5.7). If such relationships are to be included in a deterministic DCF model when conducting the scenario analysis, the relationships has not only to be identified, they also has to be specified mathematically directly in the model, adding complexity to the model.

5.4. Dealing with Non-systematic Risk in the Monte Carlo Framework

In the above discussions it was argued that by including project specific risk in an adjusted discount rate or via cost estimates that generate to low cash flows, would not be in line with what CAPM suggests. In addition it would not reveal anything about from where the risk is stemming and thus the deterministic DCF model is afflicted with certain drawbacks regarding the inclusion of non-systematic risk. By adjusting the discount rate or by adjusting the input estimates, the risk can be addressed in the valuation, however this approach hides the risk in either the discount rate or the input estimates, and consequently, in the single estimated project value. Previous research, as mentioned in section 1.5.2, has also criticized the DCF model based on most likely single point estimates due to the problem with the underlying uncertainty that is hidden in those values that in reality can undertake a continuum of different values. As discussed in section 5.3, the deterministic DCF model is afflicted with drawbacks regarding the inclusion of this non-systematic risk. As earlier discussed, the non-systematic risk in the deterministic DCF model can partially be assessed through for example sensitivity analysis or scenario analysis. However these assessment methods seldom display the whole picture. In practice it is common that firms adjust the discount rate upward to include project specific risk. In the survey undertaken by Meier & Tarhan (2007) presented in section 3.3.2, the conclusion was that even though uncertainty attributable to systematic risk had greater impact on the adjustment of the discount rate, non-systematic risk could also affect the adjustments.

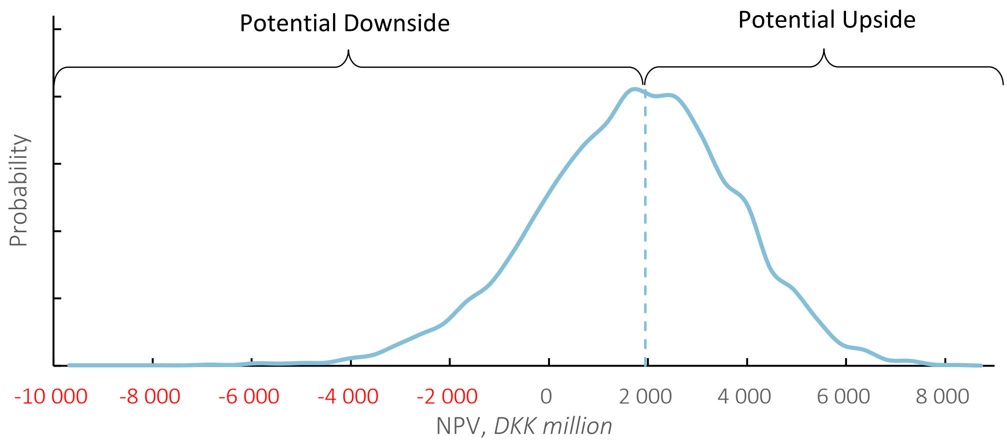
A solution to this problem with uncertain input value estimates suggested by previous researchers is the Monte Carlo simulation approach. As this approach allows for the input variable estimates to include uncertainty by specifying them as probability distributions, project specific risk is directly included in the model and consequently the risk does not have to be accounted for in adjusted cash flow forecasts or including a risk premium in the discount rate.

Since the simulated model is based on input variable estimates defined as probability distributions, the non-systematic risk in these variables is included in the probabilistic estimates. Further, the simulated model results in a distribution of the different possible project values with the estimated probabilities for these values. Therefore project specific non-systematic risk is not only included in the valuation model, it is also revealed in the final output. Since it is a commonly observed practice to adjust the discount rate as well as the forecasted cash flows, it is evident that taking project specific non-systematic risk into account when evaluating an investment prospect is in general considered important. By instead of making these subjective adjustments to the valuations, choosing to implement the Monte Carlo methodology, these risk factors could potentially be transferred from the discount rate or the cash flows to the model input distributions. Consequently, this would reveal the potential risks in the resulting probability distribution of project value, instead of keeping them concealed in a single point project value estimate.

Further, not only project risk is revealed through simulations. As the uncertain input variables potentially will have better values than estimated as most likely under the deterministic DCF approach, the simulation approach will in addition to displaying the potential risks, also display the potential upsides in terms of project values being larger than the most likely.

As shown in Figure 23, which is the output probability distribution of NPV for Project A in our case analysis, the risk is displayed as the values *below* the most likely outcome and the values *above* the most likely value represent the potential upside. Therefore it can be said that using the Monte Carlo simulation approach in project valuation not only makes it possible to include project specific risks, it also takes into account all forms of uncertainty, including potential better project values than estimated in the deterministic DCF model.

Figure 23: Potential Upside and Downside



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While this type of modeling reveals the probability for different project values to occur, it still relies on the input probability parameters being specified correctly. As this approach might require a larger number estimated parameters for each variable, there are more sources of uncertainty relating to the input estimates compared to the deterministic model, and in addition, many of these estimated parameters relies of subjective judgment. For example, as in this case study where the majority of the probabilistic input variables are approximated with triangular distributions, these parameter estimates are in general the result of experts subjectively defining the smallest and largest reasonable value, in addition to the most likely value. Consequently, as the simulated model also relies on the quality of the estimates, the principle of *garbage in, garbage out* also applies to this method.

In conclusion, applying Monte Carlo simulation to the valuation process results in a possibility to include project specific non-systematic risk in a way so that this risk is revealed in both the valuation input and output probability distributions, and not hidden in the discount rate, input estimates or in a single point estimate of the project value. However, the valuation output can never be better in terms of quality than the quality of the input variable estimations.

5.5. Other Properties of the Monte Carlo Framework

In addition to the in section 5.4 discussed benefit of simulation analysis, referring to including non-systematic risk in project valuation, the use of Monte Carlo simulation has properties that differs from the standard deterministic DCF valuation approach. In this section, these additional attributes are outlined and discussed.

5.5.1. Communication and Decision Making

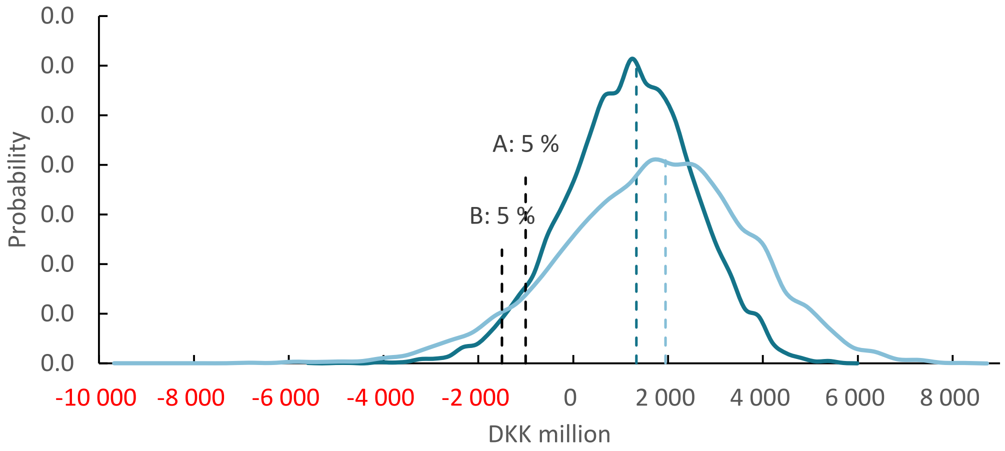
A benefit from implementing the Monte Carlo simulation analysis in the valuation process is the extensive valuation output, as previously concluded by, for example Kelliher & Mahoney (2000), Togo (2004) and Clark, et al. (2010). When the output is presented as a probability distribution of for example NPV, the decision maker have a graphical representation of all possible project NPVs, and the associated probability for each outcome, assuming that the estimates are unbiased and that the valuation model is correctly specified. The benefit is that the distribution can reveal both project risk as the probability of values below the most likely value, as well as the potential gains as the probability of values above the most likely value. The analysis of the risk can be extended to for example examining what the probability is for a NPV above zero or above any other arbitrary value.

Further, decision makers can define a confidence interval in which the NPV should lay in for the investment to be executed. For example decision makers can demand that the project NPV has to be between two specific values with 90 % probability, or above a certain value with 95 % probability.

Also, the potential skewness of the output probability distribution reveals important information about the risks associated with the investment. If for example, the distribution is skewed to the left, as for Project B in Figure 24, there is a larger probability of the final NPV being in the upper side of the range of possible NPVs, compared to Project A. As seen in Figure 24 however, the potential downside of the investment in Project B is also much larger as the smallest possible NPV is far smaller than for Project A.

In Figure 24, the output distribution for both projects in this case study is shown. This graphical representation includes 95% confidence interval, the probability of realizing a NPV above zero and the most likely value.

Figure 24: Project NPV Comparison



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As in this case analysis, when comparing two mutual exclusive projects, the Monte Carlo analysis comes especially in handy. As determined by the calculating the NPV and IRR the with single point estimates, Project B seemed more attractive with a larger NPV and IRR. However when performing the Monte Carlo simulation, it was revealed that Project B was a more risky Project. When making an investment decision, such information is very valuable as the decision makers can make a thorough assessment if the larger most likely value is worth undertaking the risk for. While Project B in our case study did not show any extreme differences in risk compared to Project A according to the Monte Carlo simulation, the difference in terms of risk could very well be revealed to be vastly important in another situation. These improved features are important benefits of the Monte Carlo based DCF model compared to the deterministic DCF where these additional levels of information are not clearly revealed.

There are other aspects related to decision-making based on the simulated valuation. As mentioned in section 2.4.2 the research methodology used in this thesis is, in addition to the case study, also supported by two interviews. A potential drawback associated with the Monte Carlo simulation that were revealed through the interview with Andreas Nahne Nickelsen however, is when presenting the result to decision makers and consequently making decisions based on the valuation output. In order to get the full potential from the implementation of the simulated model, these results has to be correctly communicated to all involved parties. Since the output from the Monte Carlo simulation includes descriptive statistics as well as a probability distribution for the project value, some sense of statistical knowledge is a requirement to fully assess the valuation result.

Further, making decisions with the simulation output as a basis requires defining what output values from the simulation process to be considered as reasonable to use in the decision making process. This can relate to measureable statistics such as the probability of the NPV being greater than zero or what are acceptable probability intervals for adequate project values. In addition to this, the output from when performing a Monte Carlo simulation in the DCF model as in this case, includes numerous descriptive statistics regarding the result, such as standard deviation, mean, median and mode, as well as the maximum and minimum resulting value. These can potentially also be used as factors for making investment decisions if using the simulation based approach.

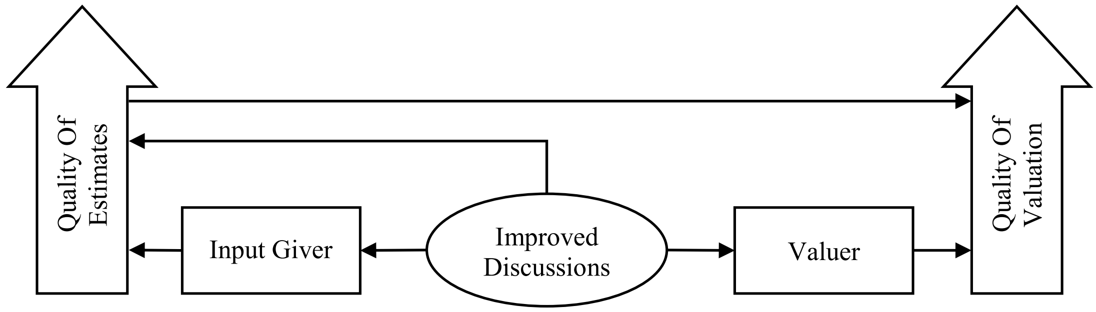
Compared to more intuitive decision making criterions as the NPV rule and the IRR rule, where the decision, although not done in practice, is meant to be taken based on a single value being larger or smaller than a specified limit, the result of Monte Carlo simulation offers a plethora of possible factors to include in the decision making process.

5.5.2. Estimating Input Distributions

Compared to the deterministic DCF model where the values of the input variables are estimated as single point estimates, defining these as probability distributions demands more extensive analysis of input variable from the input estimator. A potential gain related to this more extensive procedure which also was revealed during the interviews with both Emelie Zakrisson and Andreas Nahne Nickelsen is the extension in the thought process for the input givers. Since estimating the input variables as probability distributions, this in general requires the input giver to estimate several input parameters for each model variable. This can for example be additional maximum and minimum point estimates for a triangular distribution or the standard deviation for the normal distribution. Secondly, these additional parameters might be more demanding to estimate than the single most likely value. While the concept minimum and maximum values might be intuitively easy to grasp, this means that the input givers is required to set absolute bounds to their estimations. When only making an estimation of the most likely value it is implied that the real value may very deviate somewhat from this. However, the input estimators does not have to put an absolute number on the deviation and can always refer to the inherent uncertainties in the variable that are out of their control. By being forced to put boundaries on these uncertainties, it is implied that the actual value will lie in between these and if it does not, the input giver may be considered having performed the estimation poorly.

When the personnel responsible for the actual valuation then discuss the input estimates with the input givers, the more extensive estimates are potentially a better basis for this discussion, and for improving the estimations. With improved estimates, the whole valuation process has a great potential to improve in practice. The concept behind this idea reveled through the interviews with Nahne Nickelsen and Zakrisson is illustrated in Figure 25 where the communication between the persons involved in the valuation procedure is meant to increase.

Figure 25: Increasing the Quality of the Valuation Process



Source: Own

As discussed, the more comprehensive estimation procedure has potential gains attached to it regarding the increase in quality. However, estimating a minimum and maximum value is common practice outside the bounds of simulation analysis. The parameters are often estimated to individually assess the risk of a certain input variable, especially for performing sensitivity and scenario analysis of project values. For that reason, simply turning these estimation into statistical distributions may be a task already performed, which is also concluded by Clark, et al. (2010).

While such probability distribution types as the triangular distribution has traits making them natural to use as a progression from deterministic to simulated valuation modeling, others may need more readjustment. Relating to for example a normal distribution where the standard deviation is a required parameter to estimate, this demands at least some sense of statistical knowledge as the concept of standard deviation are far less intuitive than estimating minimum and maximum values. On the other hand, such a parameter is generally estimated from historical data which the input giver can rely on and requires far less subjective judgment.

Another aspect of estimating the valuation model inputs as probability distribution is that the distribution types actually have to be identified. Because of the different characteristics of the distribution types, different distributions are more suitable approximations of reality than other types in a given situation. Correctly fitting a probability distribution to a variable can be cumbersome. However, there are certain guidelines that can be applied when choosing the distribution type. Interviewing Emelie Zakrisson, as she is involved in the implementation of the simulated valuation model, has revealed that choosing the type of probability distribution for an input variable is generally determined by the quality of available data. In practice this means that a larger sample of historical data can be approximated with a normal distribution (see section 3.6.4). Further, when available data is limited, the input variable will likely be estimated as a triangular distribution relying to a larger extent on subjective judgment from responsible input givers, relying to a larger extent on subjective judgment from responsible input givers.

Taking all of this into account, it is evident that the input estimation procedure required for the simulation based model is more demanding in general, compared to the estimation procedure for the standard deterministic DCF valuation model. According to Zakrisson, this takes its toll by requiring more resources in terms of the input givers spending more time on performing the estimations. Further, this essentially means more work for the experts responsible of making these estimations, hence the implementation of such valuation procedure is likely to be met with resistance.

5.5.3. Correlations

As described in section 3.4.1, correlated input variables are difficult to include when assessing project risk through sensitivity and scenario analysis. An important trait of the Monte Carlo analysis is how these correlation coefficients between different input variables can be included. Incorporating the correlations in the model essentially results in the values of certain input variables being restricted by the values of other input variables. While it can be said to be possible to include such relationships in the scenario analysis, specifying these and including them in the model is a much more achievable task in the Monte Carlo simulation, as long as the correlation coefficients are identified and estimated correctly. By being able to include the correlations, the possibility of certain input variable values are deemed not to be possible and therefore excluded from the Monte Carlo simulation output. This is important since including these values would assign more probability to certain project values that in fact have a lower probability of occurring. Relating to the previously mentioned example of how the cost for installing the array cables are affected by potential delays during the construction phase, including this relationship in the Monte Carlo simulation means that if the delay is simulated to occur in a specific iteration, the cost of installing the array cables will also rise in this iteration.

It can be considered a benefit to be able to easily include correlation between variables in the simulation analysis, however identifying and quantifying these correlation is often a difficult task. If the simulation analysis is performed without including important correlation as interdependencies between these variables, the result might be rendered inconclusive. This, due to the simulation output probability distribution including a probability for events to occur that according to how the variables are interrelated cannot happen. The lack of possibility to identify errors in the simulated valuation output due to omitting real relationships between input variables may consequently affect the decision making process. The omission of correlation can potentially result in too large probabilities for acceptable project values, with the consequence of such a project being approved. In the same way too large probabilities for poor values might encourage the decision makers to approve an overvalued project.

Lastly, relating to the correlations, while the Monte Carlo simulation makes including interrelationship between input variables, it still requires the actual estimation and identification of these coefficients to be performed which is probably the most difficult part in including correlation coefficients.

6. Conclusion

The final chapter of this thesis features a presentation of conclusions drawn from this study. Based on these conclusions and the chosen research methodology, answers to the research question are presented. As several ideas for related research topics have emerged during the writing of this thesis, the last part of this chapter features suggestions for the most relevant topics that may be further researched.

By performing a case study where the methodology of Monte Carlo simulation was applied to the DCF valuation process of two mutually exclusive wind park investment, as well as performing interviews with personnel involved in the implementation of the Monte Carlo analysis at DONG Energy, we have sought to answer the research question;

"How is the transparency in project valuation using the DCF model affected if the project specific risk is simulated, rather than embedded in static valuation model input estimates?"

6.1. Conclusions of the Study

In order to reveal more information about the uncertainty that is embedded in the output of the DCF model, extending the model with Monte Carlo simulation is a useful tool. By specifying the model input variables as probability distributions rather than single point estimates and consequently running a large number of simulation iterations, a complete probability distribution of all possible project values in terms of NPV and IRR is obtained. Such probability distributions of the project value may aid managers in the decision making process when evaluating if an investment should be undertaken or not, as it provides an increased level of information compared to the deterministic DCF model based on static single point values.

The first and most apparent conclusion that can be made is that the probabilistic model output reveals the estimated probability of any given project value to occur. This gives decision makers the ability to appraise if an investment opportunity is worth being undertaken, supported by the probability of different values occurring, as this is clearly shown in the shape of the final output distribution. The investment decision can be aided with the use of criterions such as the probability of the project NPV being positive or the probability of being above a smallest acceptable project value. This dimension of increased information is in stark contrast to the deterministic DCF model, where no probabilistic data is generated at all. In addition to displaying more information about a specific investment opportunity, including Monte Carlo simulation in the valuation process also introduces specific benefits when deciding between mutually exclusive investments. The deterministic DCF model only separates potential investments in terms of a single point value, commonly presented as NPV and IRR. When instead the estimated values of the investments are presented as probability distributions, their specific risk profiles are revealed and quantified. Hence, decision makers are helped in distinguishing different opportunities also in terms of the probability of success, rather than by solely the estimated single point values generated using the deterministic approach.

A problem related to the deterministic DCF model, is this models inability to reliably include and reveal non-systematic risk in practice. According to survey evidence undertaken in previous research, a majority of firms use CAPM to calculate the cost of equity. The cost of equity is a key component of the WACC, which is most often used as the discount rate in the DCF model. As the CAPM theory only allows for the inclusion of market related risk, including non-systematic project specific risk in the discount rate requires additional efforts. This is commonly done by adding risk premiums to the discount rate in the deterministic DCF model. By subjectively adjusting the discount rate for the perceived level of non-systematic risk, this risk hidden and mixed with the systematic risk in the discount rate and finally in the project value. Accordingly, neither the size nor the origin of the non-systematic risk is disclosed, as a large number of factors are lumped together in the discount rate by an added risk premium. Another problem related to the transparency of risk in the deterministic DCF model is when individuals responsible for estimating the valuation model inputs include a safety margin in their estimates. This is an action occasionally undertaken by the input givers to account for the uncertainty in their estimates. Both these approaches hide the non-systematic risk in the static values and contribute to decreasing the risk transparency in the valuation.

Due to the lack of possibility to include specific risk in a satisfactory manner in the deterministic DCF model, risk analysis tools have been developed. To assess the project specific risk, sensitivity and scenario analysis are regularly performed. While the sensitivity analysis helps to identify value drivers with the most significant impact on the resulting project value and the scenario analysis provides investment value estimations under a set of key scenarios, neither methodology provide a fully informative analysis of the project specific risk profile.

Turning to the Monte Carlo simulation based DCF model, the input variables are specified as probability distributions. With this approach the specific non-systematic risk for each input variable is included in these distributions. When running the simulation, the output is based on the variability of the input variables whereby the project non-systematic risk is directly included and displayed in the final probability distribution of the valuation output. Including Monte Carlo simulation when performing a DCF valuation of an investment therefore allows for non-systematic risk to be moved from the discount rate or the static input variable estimates, to the input probability distributions. This means that the WACC can be estimated correctly in accordance to the previously mentioned specifications of the CAPM theory, where non-systematic risk should not be included, thus potentially bridging the gap between theory and practice. Consequently the risk profile of the investment is also displayed in a more transparent way, which makes it possible to better trace and assess the sources of the risk. Hereby additional efforts can be undertaken in order to trace, and thereby minimize the overall risk or at least make more informed investment decisions.

An additional benefit of Monte Carlo simulation included in DCF valuation is the possibility to effortlessly include correlation between input variables. While still being a demanding task to identifying the relationships between different variables, including these in the valuation model can be done easily when applying the Monte Carlo methodology to the model through specialized software.

Despite that the simulation based approach brings several important benefits compared to the deterministic DCF model, there are still limitations with this approach. Firstly, estimating the input variables as probability distributions is a significantly more demanding task compared to estimating a single static estimates, as this requires an increased number of parameters being estimated. Additionally, these are parameters that may be more difficult to evaluate compared to single point equivalents. This potentially results in more time spent on making these estimations and more resources consumed in the valuation process.

An additional limitation related to the input variables is that, despite the fact that valuation output is simulated based on probability distributions, the methodology still relies on the quality of the estimations of these distributions. As sufficient reliable historical data are not always available to base the estimations on, the estimates will be a result of the subjective judgment of involved experts. For example, when using the triangular distribution as an approximation of an input variable, while being intuitive and simple, the probability distribution parameters are usually estimated based on personal judgment. If the input variable distributions are not estimated realistically, the output distribution is not reliable and the benefit from using Monte Carlo simulation in the valuation process is somewhat lost.

The Monte Carlo simulation based DCF model provides obvious and distinct benefits in terms of revealing uncertainties in the estimated investment value and making it feasible to include non-systematic risk as well as correlation between inputs. As long as increased resource consumption can be motivated, we firmly believe that the quality of investment valuations can be significantly improved by including Monte Carlo simulation.

6.2. Suggested Future Research

Several interesting potential topics have emerged during the process of working with this thesis.

A suggested topic would be to investigate how the introduction of Monte Carlo simulation have affected the quality of the valuation model input estimates and consequently the quality of the valuation result. The Monte Carlo approach to valuation was recently implemented at DONG Energy’s Wind division at time of the writing of this thesis. Consequently it was too early to investigate if the new approach has yielded the desired improvements in the valuation results whereby it would be interesting to further investigate this topic.

The idea of the increased communication between persons involved in the valuation process that was revealed through the interviews with Zakrisson and Nahne Nickelsen could also be further investigated by a qualitative study approach where several people involved in the process would be interviewed to reveal more about this interesting potential benefit of Monte Carlo simulations found during this study.

The introduction of Monte Carlo simulation in the valuation process puts more emphasis on the input givers as they might be forced to perform more in-depth estimation of valuation inputs. For example, if a CAPEX input previously was estimated as a single point estimate, this valuation approach might require the variable to at least be estimated as triangular distributed and by this forces the input giver to present three point estimates compared to only one. In the same way, an input variable where the estimate could be based on historical data, the input giver might need to estimate the standard deviation of the data in order to estimate the variable as normal distributed. Either way, this approach might bring the input giver to reflect over the estimated values, rather than simply estimating the most probable value, implicitly saying that deviations from this value might very well occur.

As a final suggestion to future research, is an approach to the topic of Monte Carlo simulation in valuation more closely related this study is, instead of focusing on how the simulation methodology handles only non-systematic risk, an investigation could be made of how also systematic market risk can be analyzed with the Monte Carlo simulation methodology. Such a study may examine the possibility of further moving risk from the discount rate in terms of transferring systematic risk from the estimated beta value. The simulation would then also include market specific factors and it could be investigated if it might even be possible to completely omit the need for peer company based beta estimations.

6.3. Final Comments on the Conclusions

It is important to note that the above conclusions are based on this specific case study. The results are therefore subjectively affected and not directly generalizable according to constructivistic scientific view. However, according to the chosen research methodology of abduction, we are convinced that the conclusion made based on this study is valid and that the same approach applied to another capital budgeting case would render comparable results.

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List of Abbreviations

CAPM	Capital Asset Pricing Model
CFO	Chief Financial Officer
D/E	Debt to Equity ratio
DCF	Discounted Cash Flow
DKK	Danish Krona
EBIT	Earnings Before Interest and Taxes
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EPS	Earnings per share
EUR	Euro
EV	Enterprise Value
FCF	Free Cash Flow
FY1	1 Year forecasted Estimate
GW	GigaWatt
IAS	International Accounting Standards
IFRS	International Financial Reporting Standard
IFRS	International Financial Report Standards and companies that use this standard are subjected to an equal treatment of financial data.
IRR	Internal Rate of Return
kWh	Kilo watt hour
MRP	Market Risk Premium
MVE	Market Value of Equity
MWh	Mega Watt hour
ND	Net debt
NOPAT	Net Operating Profit After Tax
NOPAT	Net Operating Profit After Tax
NPV	Net Present Value
P/E	Stock Price to Earnings per Share
PDF	Probability Density Function
r_d	Cost of Debt
$r_d\,(1\text{-}t)$	After tax cost of Debt
r_e	Return on Equity
r_f	Risk Free Rate
r_m	Return on Market
$r_m - r_f$	Market Risk Premium
TTM	Trailing twelve month
WACC	Weighted Average Cost of Capital
WTG	Wind Turbine Generator
YTM	Yield to Maturity
YTM	Yield To Maturity
β	Beta

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Appendices

Appendix 1: Calculations

Relevering Beta

$$\beta_E = \beta_A \left[1 + (1+t)\frac{E}{D} \right] - \beta_D (1-t)\frac{D}{E}$$

$$1.19012 = 0.494225\left(1 + \left[\left(\frac{43032}{22921} \right)(1-0.25) \right] \right) - 0\left[\left(\frac{43032}{22921} \right)(1-0.25) \right]$$

Cost of equity according to CAPM

$$r_e = r_f + \beta_e (r_m - r_f)$$

$$0.08496 = 0.01486 + 1.19012(0,0589)$$

WACC

$$WACC = \frac{E}{E+D} r_e + \frac{D}{E+D} r_d (1-t)$$

$$4.95892 = \left(\frac{43032}{43032+22921} \right)(0.041(1-0.25)) + \left(\frac{43032}{43032+22921} \right) 0.084958$$

Appendix 2: Model

INPUTS (DKK, Thousands)

REVENUE

Subsidies	
Price (DKKk/MWh)	1,051
Duration (Years)	15 000 000

Energy Price		**Min**	**Expected**	**Max**	**Distr.**		
Energy Price (DKKk/MWh)	0,320	20%	0,320	20%	Triang		
Credit Sales (Days)	30 days		**Price Growth**	0,010			

WTG	
Manufacturer	Siemens
Model	154 6 MW
MW/WTG	6,0 MW
No. of WTGs	50
MW Wind Farm, Total	300 MW
WTGs Online/Month	10

		Expected, A	**σ**	**Distr.**
Output at 100%	2 628 000			
Capacity Factor	45%	45%	8%	Norm
Output	1 314 000			

Tax Rate	25,00%

TIMING

Project				**Min**	**Expected**	**Max**	**Distr.**
Start Date	2014-01-01		Delay (A)	0 months	0 months	4 months	Triang
Duration	27 years	days	Delay (B)	0 months	0 months	4 months	Triang
End Date	2040-12-31		Delay (C)	0 months	0 months	4 months	Triang
			Total	0 months	0 months	12 months	

Construction				
Start Date	2014-01-01			
Duration	36 months	Delay (A)	0,0 months	0,00%
End Date	2016-12-31	Delay (B)	0,0 months	0,00%
		Delay (C)	0,0 months	0,00%
		Total	0 months	

Operation	
Start Date	2017-01-01
Duration (Years)	24 years
End Date	2040-12-31

Delay	
Duration (Months)	0 months

Period Length (Months)	12 months

CAPITAL EXPEDITURES

										ρ w/ Delay		
Net Investment	**DKK/MW**	**Min**	**MostLikely**	**Max**	**σ**	**Distr.**	**Yr 1**	**Yr 2**	**Yr 3**	**A**	**B**	**C**
Resource costs	1 652	1 569	1 652	1 982		Triang	30%	60%	10%	100%	-	100%
External consultancy costs	467	458	467	476		Triang	30%	60%	10%	-	-	-
Overall project costs	2 614	2 562	2 614	2 666		Triang	30%	60%	10%	-	-	-
WTG,	10 808	10 808	10 808	10 808			30%	60%	10%	-	-	-
WTG - Other	796	796	796	796			30%	60%	10%	-	-	-
WTG Installation	1 162	1 104	1 162	1 394		Triang	30%	60%	10%	100%	-	100%
Foundations	2 812	2 671	2 812	2 953		Triang	30%	60%	10%	-	-	-
Installation of Foundations	2 894	2 749	2 894	3 473		Triang	30%	60%	10%	100%	-	100%
Array cable supply	339	322	339	356		Triang	30%	60%	10%	-	-	-
Installation of array cables	1 686	1 602	1 686	2 023		Triang	30%	60%	10%	100%	-	100%
Offshore substation, SCADA	1 963	1 924	1 963	2 002	2%	Norm	30%	60%	10%	-	-	-
Onshore substation	1 302	1 276	1 302	1 328	2%	Norm	30%	60%	10%	-	-	-
O&M facilities & equipment	180	176	180	184	2%	Norm	30%	60%	10%	-	-	-
	-						30%	60%	10%	-	-	-
Net Investment/MW, Total	**28 675**	**28 917**	**29 675**	**32 442**								

Net Investment, Total	**8 602 500**
Depreciation time (years)	24 years
Credit Purchases (Days)	30 days

OPERATIONAL EXPENDITURES

Cost	**DKK/MW**	**Min**	**Expected**	**Max**	**σ**	**Distr.**
WTGs	110	104,5	110	132		Triang
Foundations	30	29,4	30	30,6	2%	Norm
Transmission assets	80	76	80	96		Triang
Systems	139	132,05	139	166,8		Triang
Technical resources	21	20,58	21	21,42	2%	Norm
Logistics & facilities	79	77,42	79	80,58	2%	Norm
Administration	54	52,92	54	55,08	2%	Norm
Insurance	9	8,82	9	9,18	2%	Norm
Fees, taxes, environment	167	163,66	167	170,34	2%	Norm
Total	**689**	**665**	**689**	**762**		

Credit Purchases (Days)	30 days

CAPITAL STRUCTURE

Interest On Debt	4,1%
Debt Ratio	30,0%
Equity Ratio	70,0%
Cost Of Capital	
Cost Of Debt, Company	4,10%
Debt Value, Company	43 032 000
Equity Value, Company	22 921 000
Risk Free Interest Rate	1,50%
Market Premium	5,89%
Beta Company, β_C	1,190
Cost Of Equity, Company	8,51%
Tax Rate, Company	25,00%

WACC	
Company	4,97%

CALENDAR

Period	1	2	3	4	5	6	7	8	9	10	11	12	13
Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Period Start Date	2014-01-01	2015-01-01	2016-01-01	2017-01-01	2018-01-01	2019-01-01	2020-01-01	2021-01-01	2022-01-01	2023-01-01	2024-01-01	2025-01-01	2026-01-01
Period End Date	2014-12-31	2015-12-31	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31	2022-12-31	2023-12-31	2024-12-31	2025-12-31	2026-12-31
	12	12	12	12	12	12	12	12	12	12	12	12	12
Months Consutruction	12	12	12	0	0	0	0	0	0	0	0	0	0
Months Operation	0	0	0	12	12	12	12	12	12	12	12	12	12
Grid													
MW Online	0	0	0	250	300	300	300	300	300	300	300	300	300
%	0%	0%	0%	83%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Output	-	-	-	1,095,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000
Accumulated Output	-	-	-	1,095,000	2,409,000	3,723,000	5,037,000	6,351,000	7,665,000	8,979,000	10,293,000	11,607,000	12,921,000

CALENDAR, Cont.

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
2027	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**
2027-01-01	2028-01-01	2029-01-01	2030-01-01	2031-01-01	2032-01-01	2033-01-01	2034-01-01	2035-01-01	2036-01-01	2037-01-01	2038-01-01	2039-01-01	2040-01-01	2041-01-01	2042-01-01
2027-12-31	2028-12-31	2029-12-31	2030-12-31	2031-12-31	2032-12-31	2033-12-31	2034-12-31	2035-12-31	2036-12-31	2037-12-31	2038-12-31	2039-12-31	2040-12-31	2041-12-31	2042-12-31
12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	12	12	12	12	12	12	12	12	12	12	12	12	12	0	0
300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	-	-
14,235,000	15,549,000	16,863,000	18,177,000	19,491,000	20,805,000	22,119,000	23,433,000	24,747,000	26,061,000	27,375,000	28,689,000	30,003,000	31,317,000	31,317,000	31,317,000

INVESTMENT (DKK, Thousands)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Period Start Date	2014-01-01	2015-01-01	2016-01-01	2017-01-01	2018-01-01	2019-01-01	2020-01-01	2021-01-01	2022-01-01	2023-01-01	2024-01-01	2025-01-01	2026-01-01
Period End Date	2014-12-31	2015-12-31	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31	2022-12-31	2023-12-31	2024-12-31	2025-12-31	2026-12-31
Investment													
Resource costs	148,680	297,360	49,560	-	-	-	-	-	-	-	-	-	-
External consultancy costs	42,030	84,060	14,010	-	-	-	-	-	-	-	-	-	-
Overall project costs	235,260	470,520	78,420	-	-	-	-	-	-	-	-	-	-
WTG,	972,720	1,945,440	324,240	-	-	-	-	-	-	-	-	-	-
WTG - Other	71,640	143,280	23,880	-	-	-	-	-	-	-	-	-	-
WTG Installation	104,580	209,160	34,860	-	-	-	-	-	-	-	-	-	-
Foundations	253,080	506,160	84,360	-	-	-	-	-	-	-	-	-	-
Installation of Foundations	260,460	520,920	86,820	-	-	-	-	-	-	-	-	-	-
Array cable supply	30,510	61,020	10,170	-	-	-	-	-	-	-	-	-	-
Installation of array cables	151,740	303,480	50,580	-	-	-	-	-	-	-	-	-	-
Offshore substation, SCADA	176,670	353,340	58,890	-	-	-	-	-	-	-	-	-	-
Onshore substation	117,180	234,360	39,060	-	-	-	-	-	-	-	-	-	-
O&M facilities & equipment	16,200	32,400	5,400	-	-	-	-	-	-	-	-	-	-
Net Investment, Total	**2,580,750**	**5,161,500**	**860,250**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Accounts Payables													
Beginning	-	215,063	430,125	71,688	-	-	-	-	-	-	-	-	-
Payment	2,365,688	4,946,438	1,218,688	71,688	-	-	-	-	-	-	-	-	-
Ending	215,063	430,125	71,688	-	-	-	-	-	-	-	-	-	-
Depreciation													
Deprecation	-	-	-	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438
Remaining Value	2,580,750	7,742,250	8,602,500	8,244,063	7,885,625	7,527,188	7,168,750	6,810,313	6,451,875	6,093,438	5,735,000	5,376,563	5,018,125

INVESTMENT, Cont. (DKK, Thousands)

2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
2027-01-01	2028-01-01	2029-01-01	2030-01-01	2031-01-01	2032-01-01	2033-01-01	2034-01-01	2035-01-01	2036-01-01	2037-01-01	2038-01-01	2039-01-01	2040-01-01	2041-01-01	2042-01-01
2027-12-31	2028-12-31	2029-12-31	2030-12-31	2031-12-31	2032-12-31	2033-12-31	2034-12-31	2035-12-31	2036-12-31	2037-12-31	2038-12-31	2039-12-31	2040-12-31	2041-12-31	2042-12-31
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	-	-
4,659,688	4,301,250	3,942,813	3,584,375	3,225,938	2,867,500	2,509,063	2,150,625	1,792,188	1,433,750	1,075,313	716,875	358,438	-	-	-

OPERATIONS (DKK, Thousands)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Period Start Date	2014-01-01	2015-01-01	2016-01-01	2017-01-01	2018-01-01	2019-01-01	2020-01-01	2021-01-01	2022-01-01	2023-01-01	2024-01-01	2025-01-01	2026-01-01
Period End Date	2014-12-31	2015-12-31	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31	2022-12-31	2023-12-31	2024-12-31	2025-12-31	2026-12-31
Sales													
Energy Price	0.320	0.330	0.340	0.350	0.360	0.370	0.380	0.390	0.400	0.410	0.420	0.430	0.440
Average Subsidies for period	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051
Tariff	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051
Output (MWh)	-	-	-	1,095,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000
Net sales	**-**	**-**	**-**	**1,150,845**	**1,381,014**	**1,381,014**	**1,381,014**	**1,381,014**	**1,381,014**	**1,381,014**	**1,381,014**	**1,381,014**	**1,381,014**
Sales with subsidy	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Accounts Recievables													
Beginning	-	-	-	-	95,904	115,085	115,085	115,085	115,085	115,085	115,085	115,085	115,085
Payment	-	-	-	1,054,941	1,361,833	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014
Ending	-	-	-	95,904	115,085	115,085	115,085	115,085	115,085	115,085	115,085	115,085	115,085
Operational Costs													
WTGs	-	-	-	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000
Foundations	-	-	-	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Transmission assets	-	-	-	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Systems	-	-	-	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700
Technical resources	-	-	-	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300
Logistics & facilities	-	-	-	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700
Administration	-	-	-	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200
Insurance	-	-	-	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700
Fees, taxes, environment	-	-	-	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100
	-	-	-	-	-	-	-	-	-	-	-	-	-
Operational Costs, Total	**-**	**-**	**-**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**
Accounts Payables													
Beginning	-	-	-	-	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225
Payment	-	-	-	189,475	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700
Ending	-	-	-	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225

OPERATIONS, Cont. (DKK, Thousands)

2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
2027-01-01	2028-01-01	2029-01-01	2030-01-01	2031-01-01	2032-01-01	2033-01-01	2034-01-01	2035-01-01	2036-01-01	2037-01-01	2038-01-01	2039-01-01	2040-01-01	2041-01-01	2042-01-01
2027-12-31	2028-12-31	2029-12-31	2030-12-31	2031-12-31	2032-12-31	2033-12-31	2034-12-31	2035-12-31	2036-12-31	2037-12-31	2038-12-31	2039-12-31	2040-12-31	2041-12-31	2042-12-31

0.450	0.460	0.470	0.480	0.490	0.500	0.510	0.520	0.530	0.540	0.550	0.560	0.570	0.580	0.590	0.600
1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051
1.051	0.804	0.470	0.480	0.490	0.500	0.510	0.520	0.530	0.540	0.550	0.560	0.570	0.580	0.590	0.600
1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	1,314,000	-	-
1,381,014	**1,056,555**	**617,580**	**630,720**	**643,860**	**657,000**	**670,140**	**683,280**	**696,420**	**709,560**	**722,700**	**735,840**	**748,980**	**762,120**	**-**	**-**
100%	58%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

115,085	115,085	88,046	51,465	52,560	53,655	54,750	55,845	56,940	58,035	59,130	60,225	61,320	62,415	63,510	-
1,381,014	1,083,593	654,161	629,625	642,765	655,905	669,045	682,185	695,325	708,465	721,605	734,745	747,885	761,025	63,510	-
115,085	88,046	51,465	52,560	53,655	54,750	55,845	56,940	58,035	59,130	60,225	61,320	62,415	63,510	-	-

33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	-	-
9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	-	-
24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	-	-
41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	41,700	-	-
6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	-	-
23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	23,700	-	-
16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	-	-
2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	-	-
50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	50,100	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
206,700	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**206,700**	**-**	**-**

17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	-
206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	206,700	17,225	-
17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	-	-

FINANCING (DKK, Thousands)

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Period Start Date	2014-01-01	2015-01-01	2016-01-01	2017-01-01	2018-01-01	2019-01-01	2020-01-01	2021-01-01	2022-01-01	2023-01-01	2024-01-01	2025-01-01	2026-01-01
Period End Date	2014-12-31	2015-12-31	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31	2022-12-31	2023-12-31	2024-12-31	2025-12-31	2026-12-31
Financing Need													
Investment Cash Flow	-2,365,688	-4,946,438	-1,218,688	-71,688	-	-	-	-	-	-	-	-	-
Interest Payment	-	-29,098	-90,297	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398
Operational Cash Flow	-	-	-	745,639	986,277	1,018,656	1,032,340	1,046,229	1,060,326	1,074,635	1,089,159	1,103,900	1,118,863
Cash Balance	-	-	-	-	567,554	1,447,433	2,359,691	3,285,633	4,225,464	5,179,393	6,147,631	7,130,392	8,127,895
Financing Need	**2,365,688**	**4,975,535**	**1,308,985**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Debt													
Interest Payment	-	29,098	90,297	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398
New Debt	709,706	1,492,661	392,695	-	-	-	-	-	-	-	-	-	-
Amortization	-	-	-	-	-	-	-	-	-	-	-	-	-
Remaining Debt	709,706	2,202,367	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062
Equity													
Interest Payment	-	-	-	-	-	-	-	-	-	-	-	-	-
New Equity	1,655,981	3,482,875	916,289	-	-	-	-	-	-	-	-	-	-
Amortization	-	-	-	-	-	-	-	-	-	-	-	-	-
Remaining Shareholder's Loan	1,655,981	5,138,856	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145
Distribution													
Cash Available For Distribution	-	-	-	567,554	1,447,433	2,359,691	3,285,633	4,225,464	5,179,393	6,147,631	7,130,392	8,127,895	9,140,360
Dividends	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Balance													
Financial Income	-	-	-	-	11,351	28,949	47,194	65,713	84,509	103,588	122,953	142,608	162,558
Beginning	-	-	-	-	567,554	1,447,433	2,359,691	3,285,633	4,225,464	5,179,393	6,147,631	7,130,392	8,127,895
Ending	-	-	-	567,554	1,447,433	2,359,691	3,285,633	4,225,464	5,179,393	6,147,631	7,130,392	8,127,895	9,140,360

FINANCING, Cont. (DKK, Thousands)

2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
2027-01-01	2028-01-01	2029-01-01	2030-01-01	2031-01-01	2032-01-01	2033-01-01	2034-01-01	2035-01-01	2036-01-01	2037-01-01	2038-01-01	2039-01-01	2040-01-01	2041-01-01	2042-01-01
2027-12-31	2028-12-31	2029-12-31	2030-12-31	2031-12-31	2032-12-31	2033-12-31	2034-12-31	2035-12-31	2036-12-31	2037-12-31	2038-12-31	2039-12-31	2040-12-31	2041-12-31	2042-12-31

-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-
1,134,050	933,158	625,872	605,842	623,189	640,796	658,667	676,806	695,217	713,904	732,872	752,124	771,665	791,499	46,285	-
9,140,360	10,168,012	10,994,773	11,514,247	12,013,692	12,530,483	13,064,882	13,617,151	14,187,560	14,776,379	15,383,886	16,010,361	16,656,087	17,321,355	18,006,456	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	106,398	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,595,062	-
2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	-	-

-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,055,145	-
6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	-	-

10,168,012	10,994,773	11,514,247	12,013,692	12,530,483	13,064,882	13,617,151	14,187,560	14,776,379	15,383,886	16,010,361	16,656,087	17,321,355	18,006,456	17,946,344	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,296,136	-

182,807	203,360	219,895	230,285	240,274	250,610	261,298	272,343	283,751	295,528	307,678	320,207	333,122	346,427	-	-
9,140,360	10,168,012	10,994,773	11,514,247	12,013,692	12,530,483	13,064,882	13,617,151	14,187,560	14,776,379	15,383,886	16,010,361	16,656,087	17,321,355	-	-
10,168,012	10,994,773	11,514,247	12,013,692	12,530,483	13,064,882	13,617,151	14,187,560	14,776,379	15,383,886	16,010,361	16,656,087	17,321,355	18,006,456	-	-

PROFIT & LOSS (DKK, Thousands)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Period Start Date	2014-01-01	2015-01-01	2016-01-01	2017-01-01	2018-01-01	2019-01-01	2020-01-01	2021-01-01	2022-01-01	2023-01-01	2024-01-01	2025-01-01	2026-01-01
Period End Date	2014-12-31	2015-12-31	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31	2022-12-31	2023-12-31	2024-12-31	2025-12-31	2026-12-31
Sales	-	-	-	1,150,845	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014	1,381,014
OPEX	-	-	-	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700
EBITDA	**-**	**-**	**-**	**944,145**	**1,174,314**	**1,174,314**	**1,174,314**	**1,174,314**	**1,174,314**	**1,174,314**	**1,174,314**	**1,174,314**	**1,174,314**
Depreciation	-	-	-	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438
EBIT	**-**	**-**	**-**	**585,708**	**815,877**	**815,877**	**815,877**	**815,877**	**815,877**	**815,877**	**815,877**	**815,877**	**815,877**
Financial Result, Net	-	-29,098	-90,297	-106,398	-95,046	-77,449	-59,204	-40,685	-21,888	-2,810	16,555	36,210	56,160
Finciancial Income	-	-	-	-	11,351	28,949	47,194	65,713	84,509	103,588	122,953	142,608	162,558
Financial Expenditures	-	-29,098	-90,297	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398
Loss Carryforward	-	-	-29,098	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395
EBT	-	-29,098	-90,297	479,310	720,830	738,428	756,673	775,192	793,988	813,067	832,432	852,087	872,037
Income Tax	-	-	-	-119,827	-180,208	-184,607	-189,168	-193,798	-198,497	-203,267	-208,108	-213,022	-218,009
Net Income	**-**	**-29,098**	**-90,297**	**359,482**	**540,623**	**553,821**	**567,505**	**581,394**	**595,491**	**609,800**	**624,324**	**639,065**	**654,028**
Dividends	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Retained Earnings	-	-29,098	-90,297	359,482	540,623	553,821	567,505	581,394	595,491	609,800	624,324	639,065	654,028
EBIDTA Margin				82.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
EBIT Margin				50.9%	59.1%	59.1%	59.1%	59.1%	59.1%	59.1%	59.1%	59.1%	59.1%
Profit Margin				31.2%	39.1%	40.1%	41.1%	42.1%	43.1%	44.2%	45.2%	46.3%	47.4%

PROFIT & LOSS, Cont. (DKK, Thousands)

2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
2027-01-01	2028-01-01	2029-01-01	2030-01-01	2031-01-01	2032-01-01	2033-01-01	2034-01-01	2035-01-01	2036-01-01	2037-01-01	2038-01-01	2039-01-01	2040-01-01	2041-01-01	2042-01-01
2027-12-31	2028-12-31	2029-12-31	2030-12-31	2031-12-31	2032-12-31	2033-12-31	2034-12-31	2035-12-31	2036-12-31	2037-12-31	2038-12-31	2039-12-31	2040-12-31	2041-12-31	2042-12-31
1,381,014	1,056,555	617,580	630,720	643,860	657,000	670,140	683,280	696,420	709,560	722,700	735,840	748,980	762,120	-	-
-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-206,700	-	-
1,174,314	**849,855**	**410,880**	**424,020**	**437,160**	**450,300**	**463,440**	**476,580**	**489,720**	**502,860**	**516,000**	**529,140**	**542,280**	**555,420**	**-**	**-**
-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-	-
815,877	**491,418**	**52,443**	**65,583**	**78,723**	**91,863**	**105,003**	**118,143**	**131,283**	**144,423**	**157,563**	**170,703**	**183,843**	**196,983**	**-**	**-**
76,410	96,963	113,498	123,887	133,876	144,212	154,900	165,945	177,354	189,130	201,280	213,810	226,724	240,030	-106,398	-
182,807	203,360	219,895	230,285	240,274	250,610	261,298	272,343	283,751	295,528	307,678	320,207	333,122	346,427	-	-
-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-106,398	-
-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-119,395	-225,793
892,286	588,380	165,940	189,470	212,599	236,075	259,903	284,088	308,636	333,553	358,843	384,512	410,567	437,012	-106,398	-
-223,072	-147,095	-41,485	-47,367	-53,150	-59,019	-64,976	-71,022	-77,159	-83,388	-89,711	-96,128	-102,642	-109,253	-	-
669,215	**441,285**	**124,455**	**142,102**	**159,449**	**177,056**	**194,927**	**213,066**	**231,477**	**250,164**	**269,132**	**288,384**	**307,925**	**327,759**	**-106,398**	**-**
-	-	-	-	-	-	-	-	-	-	-	-	-	-	**9,296,136**	-
669,215	441,285	124,455	142,102	159,449	177,056	194,927	213,066	231,477	250,164	269,132	288,384	307,925	327,759	-9,402,534	-
85.0%	80.4%	66.5%	67.2%	67.9%	68.5%	69.2%	69.7%	70.3%	70.9%	71.4%	71.9%	72.4%	72.9%		
59.1%	46.5%	8.5%	10.4%	12.2%	14.0%	15.7%	17.3%	18.9%	20.4%	21.8%	23.2%	24.5%	25.8%		
48.5%	41.8%	20.2%	22.5%	24.8%	26.9%	29.1%	31.2%	33.2%	35.3%	37.2%	39.2%	41.1%	43.0%		

BALANCE SHEET (DKK, Thousands)

Year	2014	2015	2016	2017	2018	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Period Start Date	2014-01-01	2015-01-01	2016-01-01	2017-01-01	2018-01-01	2019-01-01	2020-01-01	2021-01-01	2022-01-01	2023-01-01	2024-01-01	2025-01-01	2026-01-01
Period End Date	2014-12-31	2015-12-31	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31	2022-12-31	2023-12-31	2024-12-31	2025-12-31	2026-12-31
ASSETS													
Non-Current Assets													
At Cost	2,580,750	7,742,250	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500
Depreciation	-	-	-	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438
After Depreciation	2,580,750	7,742,250	8,602,500	8,244,063	7,885,625	7,527,188	7,168,750	6,810,313	6,451,875	6,093,438	5,735,000	5,376,563	5,018,125
Non-Current Assets, Total	2,580,750	7,742,250	8,602,500	8,244,063	7,885,625	7,527,188	**7,168,750**	**6,810,313**	**6,451,875**	**6,093,438**	**5,735,000**	**5,376,563**	**5,018,125**
Current Assets													
Accounts Recievables	-	-	-	95,904	115,085	115,085	115,085	115,085	115,085	115,085	115,085	115,085	115,085
Cash & Cash Equivivalents	-	-	-	567,554	1,447,433	2,359,691	3,285,633	4,225,464	5,179,393	6,147,631	7,130,392	8,127,895	9,140,360
Current Assets, Total	-	-	-	663,457	1,562,517	2,474,776	**3,400,718**	**4,340,549**	**5,294,478**	**6,262,715**	**7,245,476**	**8,242,979**	**9,255,444**
TOTAL ASSETS	2,580,750	7,742,250	8,602,500	8,907,520	9,448,142	10,001,963	**10,569,468**	**11,150,861**	**11,746,353**	**12,356,153**	**12,980,476**	**13,619,542**	**14,273,569**
EQUITY&LIABILITIES													
Equity													
Shareholder's Loan	1,655,981	5,138,856	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145
Accumulated Retained Earnings	-	-29,098	-119,395	240,087	780,710	1,334,531	1,902,035	2,483,429	3,078,920	3,688,720	4,313,044	4,952,109	5,606,137
TOTAL EQUITY	1,655,981	5,109,758	5,935,750	6,295,233	6,835,855	7,389,676	7,957,181	8,538,574	9,134,065	9,743,866	10,368,189	11,007,254	11,661,282
Liabilities													
Non-current Liabilities													
Debt	709,706	2,202,367	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062
Non-current Liabilities, Total	709,706	2,202,367	2,595,062	2,595,062	2,595,062	2,595,062	**2,595,062**	**2,595,062**	**2,595,062**	**2,595,062**	**2,595,062**	**2,595,062**	**2,595,062**
Current Liabilities													
Accounts Payables, Investment	215,063	430,125	71,688	-	-	-	-	-	-	-	-	-	-
Accounts Payables, Operations	-	-	-	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225
Current Liabilities, Total	215,063	430,125	71,688	17,225	17,225	17,225	**17,225**	**17,225**	**17,225**	**17,225**	**17,225**	**17,225**	**17,225**
TOTAL LIABILITIES	924,769	2,632,492	2,666,750	2,612,287	2,612,287	2,612,287	**2,612,287**	**2,612,287**	**2,612,287**	**2,612,287**	**2,612,287**	**2,612,287**	**2,612,287**
TOTAL EQUITY & LIABILITIES	2,580,750	7,742,250	8,602,500	8,907,520	9,448,142	10,001,963	**10,569,468**	**11,150,861**	**11,746,353**	**12,356,153**	**12,980,476**	**13,619,542**	**14,273,569**

BALANCE SHEET, Cont. (DKK, Thousands)

2027	2028	2029	2030	2031	2032	2033	2034	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**
2027-01-01	2028-01-01	2029-01-01	2030-01-01	2031-01-01	2032-01-01	2033-01-01	2034-01-01	2035-01-01	2036-01-01	2037-01-01	2038-01-01	2039-01-01	2040-01-01	2041-01-01
2027-12-31	2028-12-31	2029-12-31	2030-12-31	2031-12-31	2032-12-31	2033-12-31	2034-12-31	2035-12-31	2036-12-31	2037-12-31	2038-12-31	2039-12-31	2040-12-31	2041-12-31
8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	8,602,500	-
-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-358,438	-
4,659,688	4,301,250	3,942,813	3,584,375	3,225,938	2,867,500	2,509,063	2,150,625	1,792,188	1,433,750	1,075,313	716,875	358,438	-	-
4,659,688	4,301,250	3,942,813	3,584,375	3,225,938	2,867,500	2,509,063	2,150,625	**1,792,188**	**1,433,750**	**1,075,313**	**716,875**	**358,438**	**-**	**-**
115,085	88,046	51,465	52,560	53,655	54,750	55,845	56,940	58,035	59,130	60,225	61,320	62,415	63,510	-
10,168,012	10,994,773	11,514,247	12,013,692	12,530,483	13,064,882	13,617,151	14,187,560	14,776,379	15,383,886	16,010,361	16,656,087	17,321,355	18,006,456	-
10,283,096	11,082,819	11,565,712	12,066,252	12,584,138	13,119,632	13,672,996	14,244,500	**14,834,414**	**15,443,016**	**16,070,586**	**16,717,407**	**17,383,770**	**18,069,966**	**-**
14,942,784	15,384,069	15,508,524	15,650,627	15,810,076	15,987,132	16,182,059	16,395,125	**16,626,602**	**16,876,766**	**17,145,898**	**17,434,282**	**17,742,207**	**18,069,966**	**-**
6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	6,055,145	-
6,275,351	6,716,636	6,841,092	6,983,194	7,142,643	7,319,699	7,514,626	7,727,692	7,959,169	8,209,334	8,478,466	8,766,850	9,074,775	9,402,534	-
12,330,497	12,771,782	12,896,237	13,038,339	13,197,788	13,374,844	13,569,771	13,782,837	14,014,314	14,264,479	14,533,611	14,821,995	15,129,920	15,457,679	-
2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	-
2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	2,595,062	**2,595,062**	**2,595,062**	**2,595,062**	**2,595,062**	**2,595,062**	**2,595,062**	**-**
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	-
17,225	17,225	17,225	17,225	17,225	17,225	17,225	17,225	**17,225**	**17,225**	**17,225**	**17,225**	**17,225**	**17,225**	**-**
2,612,287	2,612,287	2,612,287	2,612,287	2,612,287	2,612,287	2,612,287	2,612,287	**2,612,287**	**2,612,287**	**2,612,287**	**2,612,287**	**2,612,287**	**2,612,287**	**-**
14,942,784	15,384,069	15,508,524	15,650,627	15,810,076	15,987,132	16,182,059	16,395,125	**16,626,602**	**16,876,766**	**17,145,898**	**17,434,282**	**17,742,207**	**18,069,966**	**-**

CASH FLOW (DKK, Thousands)

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Period Start Date	2014-01-01	2015-01-01	2016-01-01	2017-01-01	2018-01-01	2019-01-01	2020-01-01	2021-01-01	2022-01-01	2023-01-01	2024-01-01	2025-01-01	2026-01-01
Period End Date	2014-12-31	2015-12-31	2016-12-31	2017-12-31	2018-12-31	2019-12-31	2020-12-31	2021-12-31	2022-12-31	2023-12-31	2024-12-31	2025-12-31	2026-12-31
Operations													
EBT	-	-29,098	-90,297	479,310	720,830	738,428	756,673	775,192	793,988	813,067	832,432	852,087	872,037
+ Depreciation	-	-	-	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438
Income Tax, Payed	-	-	-	-119,827	-180,208	-184,607	-189,168	-193,798	-198,497	-203,267	-208,108	-213,022	-218,009
Op Cash Flow, Before NWC	**-**	**-29,098**	**-90,297**	**717,920**	**899,060**	**912,258**	**925,942**	**939,831**	**953,929**	**968,238**	**982,761**	**997,503**	**1,012,465**
Δ Accounts Recievables	-	-	-	-95,904	-19,181	-	-	-	-	-	-	-	-
Δ Accounts Payables	-	-	-	17,225	-	-	-	-	-	-	-	-	-
Operations Cash Flow	-	-29,098	-90,297	639,241	879,879	912,258	925,942	939,831	953,929	968,238	982,761	997,503	1,012,465
Investing													
Δ Non-Current Assets	-2,580,750	-5,161,500	-860,250	-	-	-	-	-	-	-	-	-	-
Δ Accounts Payables	215,063	215,063	-358,438	-71,688	-	-	-	-	-	-	-	-	-
Investing Cash Flow	**-2,365,688**	**-4,946,438**	**-1,218,688**	**-71,688**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing													
New Debt	709,706	1,492,661	392,695	-	-	-	-	-	-	-	-	-	-
Repayment of Debt	-	-	-	-	-	-	-	-	-	-	-	-	-
New Shareholder's Loan	1,655,981	3,482,875	916,289	-	-	-	-	-	-	-	-	-	-
Repayment of Shareholder's Loan	-	-	-	-	-	-	-	-	-	-	-	-	-
Dividends	-	-	-	-	-	-	-	-	-	-	-	-	-
Financing Cash Flow	2,365,688	4,975,535	1,308,985	-	-	-	-	-	-	-	-	-	-
Cash Flow Before Payout FCF	-	-	-	567,554	879,879	912,258	925,942	939,831	953,929	968,238	982,761	997,503	1,012,465
Cash Flow For Period	-	-	-	567,554	879,879	912,258	925,942	939,831	953,929	968,238	982,761	997,503	1,012,465
Cash Balance, Ending	-	-	-	567,554	1,447,433	2,359,691	3,285,633	4,225,464	5,179,393	6,147,631	7,130,392	8,127,895	9,140,360
FCFF	-2,365,688	-4,975,535	-1,308,985	567,554	879,879	912,258	925,942	939,831	953,929	968,238	982,761	997,503	1,012,465

2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
2027-01-01	2028-01-01	2029-01-01	2030-01-01	2031-01-01	2032-01-01	2033-01-01	2034-01-01	2035-01-01	2036-01-01	2037-01-01	2038-01-01	2039-01-01	2040-01-01	2041-01-01	2042-01-01
2027-12-31	2028-12-31	2029-12-31	2030-12-31	2031-12-31	2032-12-31	2033-12-31	2034-12-31	2035-12-31	2036-12-31	2037-12-31	2038-12-31	2039-12-31	2040-12-31	2041-12-31	2042-12-31
892,286	588,380	165,940	189,470	212,599	236,075	259,903	284,088	308,636	333,553	358,843	384,512	410,567	437,012	-106,398	-
358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	358,438	-	-
-223,072	-147,095	-41,485	-47,367	-53,150	-59,019	-64,976	-71,022	-77,159	-83,388	-89,711	-96,128	-102,642	-109,253	-	-
1,027,652	**799,723**	**482,893**	**500,540**	**517,887**	**535,493**	**553,364**	**571,503**	**589,915**	**608,602**	**627,570**	**646,822**	**666,363**	**686,197**	**-106,398**	**-**
-	27,038	36,581	-1,095	-1,095	-1,095	-1,095	-1,095	-1,095	-1,095	-1,095	-1,095	-1,095	-1,095	63,510	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-17,225	-
1,027,652	826,761	519,474	499,445	516,792	534,398	552,269	570,408	588,820	607,507	626,475	645,727	665,268	685,102	-60,113	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-2,595,062	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-6,055,145	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-9,296,136	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	#########	-
1,027,652	826,761	519,474	499,445	516,792	534,398	552,269	570,408	588,820	607,507	626,475	645,727	665,268	685,102	-60,113	-
1,027,652	826,761	519,474	499,445	516,792	534,398	552,269	570,408	588,820	607,507	626,475	645,727	665,268	685,102	#########	-
10,168,012	10,994,773	11,514,247	12,013,692	12,530,483	13,064,882	13,617,151	14,187,560	14,776,379	15,383,886	16,010,361	16,656,087	17,321,355	18,006,456	-	-
1,027,652	826,761	519,474	499,445	516,792	534,398	552,269	570,408	588,820	607,507	626,475	645,727	665,268	685,102	-60,113	-
1,027,652	826,761	519,474	499,445	516,792	534,398	552,269	570,408	588,820	607,507	626,475	645,727	665,268	685,102	-2,655,175	-
308,296	248,028	155,842	149,833	155,037	160,320	165,681	171,123	176,646	182,252	187,942	193,718	199,580	205,530	-18,034	-
719,356	578,733	363,632	349,611	361,754	374,079	386,589	399,286	412,174	425,255	438,532	452,009	465,687	479,571	-42,079	-
1,027,652	826,761	519,474	499,445	516,792	534,398	552,269	570,408	588,820	607,507	626,475	645,727	665,268	685,102	-60,113	-

Appendix 3: Definitions of Model Value Drivers

Capital Expenditures	**Definition of Input**	**Cost Driver**
Resource Costs	Internal human resources used for the project in all areas and phases.	Rates per hour and project duration.
External Consultancy Costs	External consultancy costs used for various areas and phases.	Rates per hour consultancy and project duration.
Overall Project Costs	Travel expenses, project office costs, administration and others.	Various cost drivers, e.g. duration, number of travels etcetera.
WTG	WTG supply costs as specified in the Turbine Supply Agreement (TSA). The TSA agreement is a contract between the developer and the WTG manufacturer, which includes the agreement to supply a specific number of turbines with specific features within a certain time frame.	Scope of the supply of turbines and the contracted price and time frame.
WTG – Other	WTG turbine costs not included in the supply agreement such as options and turbine design.	Specific desired requirements of the WTG turbines.
WTG Installation	Installation costs related to vessels hire and other related costs to the installation of the WTGs.	Vessels hire rates and installation length. Weather conditions and unexpected problems may delay the installation.
Foundations Supply and Installation	Supply of foundation components such as monopoles, transition pieces and vessels hire. The monopiles are the cyclical steel tubes that are hammer into the seabed.	Cost is driven by weight, steel price, geotechnical conditions at site and installation length.
Array and Export Cable Supply and Installation.	The array cables connect the WTGs to each other and to the offshore substation. The Export cables connect the offshore substation with the onshore substation.	Supply, transport, cable length, copper price and installation method.
Offshore Substation and SCADA	The offshore substation collects the electricity generated by the WTGs and step up the voltage before transmission to shore via export cables. SCADA refers to the Supervisory control and data acquisition, which is a control system that monitor and control the power production.	Offshore substation supply, steel price, geotechnical conditions and vessel rates.
Onshore Substation	The onshore substation receives the power from the offshore substation via the export cables and flow it into the national electricity network.	Onshore equipment supply and installation for both high and low volt.
O&M Facilities & Equipment	Operations and maintenance facilities and warehouse building for O&M purpose. Focus on safety service and construction of the wind farm. Includes control and monitoring facilities to analyze the conditions before every trip out to the farm in the harsh marine environment.	Construction method and installation cost.

Operational Expenditures	**Definition of Input**	**Cost Driver**
WTGs	Includes Service and Warranty Agreement payments, preventive maintenance costs and corrective maintenance costs during the life of the wind farm.	The Main cost drivers are service rates, indexation, lifetime of components, failure rates and components prices.
Foundations	Foundations maintenance during the lifetime of the Wind park.	Lifetime and price of components are the main cost drivers.
Transmission Assets	General maintenance of cables, which includes array and export cables.	Length and number of cables as inspection costs are based on fixed cost/km plus mobilization/demobilization cost.
Systems	Maintenance of supervision and control systems such as the SCADA system maintenance and service agreement.	Cost is related to distance to shore and park capacity.
Technical resources	Preventive and corrective technicians cost.	Mainly the number of technicians and their hourly salary rate drives the cost.
Logistics & Facilities	Includes crew vessel, helicopter, jack-up vessel and site facilities.	Sailing hours and fuel prices for vessels and flying hours and hourly rates for helicopters. Size and location of the facilities and the wind farm.
Administration	Onsite, middle and back office administration costs.	Number of employees and salaries.
Insurance	Property damage, general and liability insurance costs.	Choice of insurance structure.
Fees, Taxes, Environment	Market specific fees such as leases, taxes and cost of environmental monitoring.	Depending upon site and cable routes and market conditions.

Source: Dong Energy

Appendix 4: Electricity Price Data from Nord Pool Spot

Monthly Obersvations

Month	Obersveration	Month	Obersveration	Month	Obersveration	Month	Obersveration
a-03	213.935	n-05	352.07	j-08	507.045	j-11	399.575
m-03	215.17	d-05	314.915	j-08	488.435	f-11	387.595
j-03	198.305	j-06	340	a-08	485.015	m-11	411.315
j-03	229.405	f-06	364.035	s-08	579.29	a-11	390.275
a-03	261.98	m-06	399.795	o-08	473.565	m-11	407.95
s-03	250.065	a-06	351.18	n-08	412.935	j-11	388.715
o-03	261.35	m-06	266.695	d-08	376.88	j-11	318.59
n-03	254.025	j-06	334.1	j-09	325.915	a-11	350.955
d-03	207.725	j-06	362.685	f-09	292.97	s-11	357.97
j-04	207.885	a-06	426.955	m-09	263.495	o-11	333.73
f-04	199.93	s-06	384.1	a-09	259.31	n-11	355.11
m-04	210.45	o-06	346.97	m-09	246.275	d-11	254.89
a-04	200.4	n-06	316.525	j-09	266.69	j-12	277.54
m-04	209.825	d-06	257.97	j-09	255.5	f-12	378.29
j-04	241.605	j-07	197.365	a-09	281.17	m-12	236.105
j-04	208.935	f-07	220.085	s-09	277.11	a-12	263.205
a-04	251.305	m-07	182.935	o-09	302.35	m-12	269.115
s-04	219.845	a-07	185.385	n-09	289.11	j-12	275.75
o-04	198.795	m-07	181.125	d-09	331.7	j-12	200.61
n-04	209.795	j-07	233.535	j-10	407.115	a-12	294.165
d-04	192.395	j-07	188.665	f-10	511.19	s-12	280.405
j-05	171.08	a-07	211.57	m-10	366.39	o-12	284.42
f-05	196.6	s-07	253.18	a-10	305.875	n-12	264.675
m-05	258.275	o-07	374.47	m-10	301.38	d-12	282.06
a-05	243.73	n-07	352.935	j-10	331.64	j-13	304.63
m-05	252.6	d-07	341.72	j-10	350.11	f-13	296.89
j-05	271.51	j-08	351.805	a-10	337.405	m-13	305.315
j-05	267.04	f-08	338.435	s-10	376.3	a-13	321.93
a-05	261.405	m-08	270.225	o-10	378.52		
s-05	286.78	a-08	376.365	n-10	396.595		
o-05	296.415	m-08	398.405	d-10	566.865		

Yearly Obersvations

Year	Obersveration	Year	Obersveration
2011	225.8520833	2006	415.02625
2010	213.2379167	2005	316.1591667
2009	304.19125	2004	378.5979167
2008	303.96375	2003	337.51
2007	273.5875	2002	276.77

Statistics

	Monthly	Yearly
Intercept	247.997	
Slope	0.9439453	11.327344
Average	304.63372	
Stdev	84.269472	
Stdev, %	0.2766256	3.3195067
Max	579.29	
Min	171.08	

Appendix 5: Market Risk Premium Data

OMX Nordic KAX			10Y Danish Gov. Bonds	Market Premium	OMX Nordic KAX			10Y Danish Gov. Bonds	Market Premium
Date	**Price**	**Return**	**Return**	**Return**	**Date**	**Price**	**Return**	**Return**	**Return**
j-03	103.64				j-08	205.88	-0.36%	0.37%	-0.73%
j-03	102.82	-0.79%	0.32%	-1.11%	j-08	178.25	-13.42%	0.40%	-13.82%
a-03	107.4	4.45%	0.35%	4.11%	a-08	176.97	-0.72%	0.40%	-1.12%
s-03	116.94	8.88%	0.36%	8.52%	s-08	182.53	3.14%	0.38%	2.77%
o-03	113.03	-3.34%	0.37%	-3.71%	o-08	151.02	-17.26%	0.37%	-17.63%
n-03	123.69	9.43%	0.37%	9.06%	n-08	128.35	-15.01%	0.37%	-15.38%
d-03	123.4	-0.23%	0.38%	-0.62%	d-08	108.58	-15.40%	0.34%	-15.74%
j-04	124.52	0.91%	0.38%	0.53%	j-09	115.53	6.40%	0.30%	6.10%
f-04	131.23	5.39%	0.36%	5.03%	f-09	105.63	-8.57%	0.29%	-8.86%
m-04	137.81	5.01%	0.36%	4.66%	m-09	95.71	-9.39%	0.30%	-9.69%
a-04	134.24	-2.59%	0.34%	-2.93%	a-09	105.31	10.03%	0.29%	9.74%
m-04	127.99	-4.66%	0.36%	-5.01%	m-09	124.11	17.85%	0.30%	17.56%
j-04	124.75	-2.53%	0.37%	-2.90%	j-09	132.52	6.78%	0.31%	6.47%
j-04	130.53	4.63%	0.38%	4.26%	j-09	129.69	-2.14%	0.31%	-2.45%
a-04	125.34	-3.98%	0.38%	-4.36%	a-09	142.57	9.93%	0.31%	9.62%
s-04	127.15	1.44%	0.37%	1.07%	s-09	145.34	1.94%	0.30%	1.64%
o-04	134.41	5.71%	0.37%	5.34%	o-09	146.7	0.94%	0.31%	0.63%
n-04	134.62	0.16%	0.35%	-0.20%	n-09	147.55	0.58%	0.30%	0.28%
d-04	142.2	5.63%	0.34%	5.29%	d-09	151.82	2.89%	0.30%	2.59%
j-05	141.92	-0.20%	0.32%	-0.52%	j-10	159.1	4.80%	0.30%	4.50%
f-05	143.59	1.18%	0.31%	0.87%	f-10	162.36	2.05%	0.30%	1.75%
m-05	150.49	4.81%	0.30%	4.50%	m-10	165.84	2.14%	0.29%	1.85%
a-05	150.24	-0.17%	0.32%	-0.48%	a-10	178.74	7.78%	0.28%	7.49%
m-05	145.94	-2.86%	0.30%	-3.16%	m-10	181.57	1.58%	0.28%	1.30%
j-05	155.62	6.63%	0.28%	6.35%	j-10	169.21	-6.81%	0.24%	-7.05%
j-05	159.5	2.49%	0.26%	2.23%	j-10	165.14	-2.41%	0.23%	-2.63%
a-05	165.23	3.59%	0.27%	3.33%	a-10	183.83	11.32%	0.23%	11.09%
s-05	166.86	0.99%	0.27%	0.72%	s-10	180.06	-2.05%	0.20%	-2.26%
o-05	175.92	5.43%	0.25%	5.18%	o-10	188.44	4.65%	0.20%	4.45%
n-05	167.96	-4.52%	0.27%	-4.79%	n-10	190.83	1.27%	0.21%	1.06%
d-05	176.21	4.91%	0.29%	4.62%	d-10	197.3	3.39%	0.22%	3.17%
j-06	186.34	5.75%	0.28%	5.47%	j-11	212.02	7.46%	0.25%	7.21%
f-06	192.38	3.24%	0.28%	2.96%	f-11	211	-0.48%	0.26%	-0.74%
m-06	196.31	2.04%	0.29%	1.75%	m-11	207.43	-1.69%	0.27%	-1.96%
a-06	208.39	6.15%	0.31%	5.84%	a-11	207.57	0.07%	0.28%	-0.21%
m-06	207.46	-0.45%	0.33%	-0.78%	m-11	210.14	1.24%	0.28%	0.95%
j-06	193.74	-6.61%	0.34%	-6.95%	j-11	205.07	-2.41%	0.26%	-2.67%
j-06	192.34	-0.72%	0.34%	-1.06%	j-11	194.33	-5.24%	0.25%	-5.49%
a-06	189	-1.74%	0.34%	-2.07%	a-11	180.56	-7.09%	0.25%	-7.34%
s-06	197.51	4.50%	0.33%	4.18%	s-11	165.21	-8.50%	0.21%	-8.71%
o-06	203.82	3.19%	0.32%	2.88%	o-11	153.04	-7.37%	0.17%	-7.54%
n-06	214.74	5.36%	0.32%	5.03%	n-11	160.3	4.74%	0.19%	4.56%
d-06	215.03	0.14%	0.31%	-0.18%	d-11	163.45	1.97%	0.17%	1.80%
j-07	232.72	8.23%	0.32%	7.91%	j-12	170.39	4.25%	0.16%	4.09%
f-07	239.77	3.03%	0.33%	2.70%	f-12	182.9	7.34%	0.15%	7.19%
m-07	229.01	-4.49%	0.34%	-4.83%	m-12	192.17	5.07%	0.16%	4.91%
a-07	239.8	4.71%	0.33%	4.38%	a-12	191	-0.61%	0.16%	-0.77%
m-07	253.31	5.63%	0.35%	5.28%	m-12	184.48	-3.41%	0.14%	-3.56%

j-07	261.9	3.39%	0.36%	3.03%	j-12	164.35	-10.91%	0.11%	-11.02%
j-07	256.78	-1.95%	0.39%	-2.34%	j-12	177.19	7.81%	0.11%	7.71%
a-07	251.02	-2.24%	0.38%	-2.63%	a-12	189.16	6.76%	0.09%	6.66%
s-07	252.49	0.59%	0.37%	0.22%	s-12	188.04	-0.59%	0.10%	-0.69%
o-07	258.23	2.27%	0.36%	1.91%	o-12	193.22	2.75%	0.13%	2.62%
n-07	253.77	-1.73%	0.37%	-2.09%	n-12	188.67	-2.35%	0.13%	-2.48%
d-07	237.16	-6.55%	0.35%	-6.90%	d-12	192.3	1.92%	0.12%	1.81%
j-08	227.83	-3.93%	0.36%	-4.30%	j-13	201.14	4.60%	0.12%	4.48%
f-08	209.36	-8.11%	0.35%	-8.45%	f-13	209.3	4.06%	0.14%	3.92%
m-08	207.01	-1.12%	0.34%	-1.46%	m-13	216.45	3.42%	0.15%	3.27%
a-08	207.21	0.10%	0.34%	-0.24%	a-13	218.66	1.02%	0.13%	0.89%
m-08	206.63	-0.28%	0.36%	-0.64%	m-13	213.29	-2.46%	0.12%	-2.57%

Sources: http://www.bloomberg.com/quote/KAX:IND, Sveriges Riksbank (2013)

Appendix 6: Renewable Energy Peer Group

Alerion Clean Power SpA (ARN-MI)

Alerion Clean Power SpA is an Italy-based holding company mainly engaged in the renewable energy sector. The Company is involved in the electrical power generation and electricity production through renewable energy sources with a great focus on onshore wind farms, but Alerion is also engaged in business related to solar energy panels and biomass energy plants. The Company's power plants are located in Italy, Romania and Bulgaria.

Source: http://www.alerion.it/company/profile/?lang=en

EDP Renovaveis SA (EDPR-LB)

EDP Renovaveis SA is a Spanish company active in the renewable energy sector. The Company is specialized in the production of energy from renewable sources and the activities include development, operation and maintenance of electric power stations based on hydroelectric, wind, solar, tidal, biomass and waste plants. The focus is however on wind power generation and projects onshore on a global level since. The company operates in Spain, Portugal, Belgium, France, Italy, the Netherlands, Poland, Romania, the UK but also in the United States and Canada.

Source: http://www.edpr.com

Enel Green Power SpA (EGPW-MI)

Enel Green Power SpA is an Italy-based Company active in the development and management of energy production from renewable sources. The Company generates wind, Solar, geothermal, hydroelectric water flow and biomass energies at an international level with presence in Spain, Portugal, France, Italy, Romania, Bulgaria, Greece, the U.S. , Canada and some countries in south America. The Company is listed on both the Italian and Spanish stock exchanges and is a subsidiary of Enel SpA.

Source: http://www.enelgreenpower.com/en-GB/

Falck Renewables SpA (FKR-MI)

Falck Renewables SpA is an Italy-based firm primarily involved in the renewable energy sector. The Company is active in the production of renewable energy through wind farms, waste-to-energy (WtE) process, biomass and photovoltaic (PV) plants. However, it is also engaged in the waste treatment and disposal. The Company is active in Italy, the United Kingdom and France.

Source: http://www.falckrenewables.eu/?sc_lang=en

Fersa Energigas Renovables SA (FRS-MC)

Fersa Energias Renovables SA is a Spain-based company that is primarily involved in the promotion and development of renewable energy projects. Through its subsidiaries, the Company is engaged in the generation of wind, solar and biomass energy. Additionally, the Company has operations established in Spain, France, Italy, Montenegro, Poland, Estonia, India, China and Panama. The company is a good peer since 98% of their business is related to wind power production.

Source: http://www.fersa.es/index.php?leng=en

PNE Wind AG (PNEN-XE)

PNE Wind AG is a German company engaged in the development, realization, financing and operation of wind farms. The Company diversifies its activities into two business segments: wind power (onshore and offshore) and electricity generation. The company has a portfolio of already realized German wind farm projects but also international projects under development, both on and offshore. The electricity generation segment includes all activities related directly in the production of electricity from renewable energy through wind farms. Furthermore, PNE is the only peers solely engaged in wind power and in addition offshore projects.

Source: http://www.pnewind.com/en.html

Theolia SA (TEO-FR)

Theolia SA is a France-based developer and operator of wind farm projects. The Company's activities are focused on the development of wind farm projects and construction of installations that generate wind power for the Company's own account and for third parties. The projects are located in France, Germany, Morocco and Italy. Theolia’s activities and business services apply to the entire value chain of the wind energy sector ranging from site identification to the operation of commissioned wind farms, including the process by which permission for construction and operation is obtained, the selection of turbines, the completion of studies, research and raising of capital. Theolia is a relevant peer since they are mainly involved in wind power production even though it is onshore.

Source: http://www.theolia.com/en/

Appendix 7: DONG Energy Peer Group

E.ON (EOAN-XE)

E.ON SE is a Germany-based provider of energy solutions. The Company manages the E.ON Group, which consists of five global units and 12 regional units. The global units consist of four business segments: Generation, Renewables, Gas, Trading and a fifth unit; New Building & Technology, which comprises project management and engineering related to construction of power plants and the operation of existing plants, as well as research and development projects for the E.ON Innovation Centers. The Generation segment consists of the conventional (fossil and nuclear) generation assets in Europe. The Renewables segment includes the carbon-sourcing and renewables businesses. The Gas segment is responsible for gas procurement, including gas production, and for project and product development in gas storage, gas transport, liquefied natural gas. The Trading segment comprises all trading activities on energy exchanges. The company is one of the largest investor-owned electric utility service providers.

Source: http://www.eon.com/en.html

Electricite de France SA (EDF-FR)

Electricite de France SA is an former state-owned electricity producer and marketer based in France. The Company generates energy using nuclear technology, as well as thermal, hydroelectric and other renewable energy sources. It is involved in energy generation and energy sales to industries, local authorities and residential consumers. In addition, EDF manages a public low and medium-voltage distribution network and is involved in the electricity transmission network. It also provides energy services such as district heating and thermal energy services. The group is currently mainly present in France, Belgium, Poland, Italy, China and the U.S.

Source: http://www.edf.com/the-edf-group-42667.html

Enel SpA (ENEL-MI)

Enel SpA, is an Italy-based company engaged in the power and gas sectors. The Company produces, distributes, and sells electricity and natural gas across Europe, Russia, North America and Latin America. It operates a range of hydroelectric, thermoelectric, nuclear, geothermal, wind-power, photovoltaic and biomass power stations. Enel SpA operates in business areas such as: Market, Production, Energy Management, Engineering and Innovation, Infrastructure and Networks and Renewable Energies. The company is formerly state-owned and has one of the largest in Europe by market capitalization.

Source: http://www.enel.com/en-GB/

Fortum (FUM1V-HE)

Fortum Oyj is a Finland-based energy company. It operates within four divisions: Power, comprising Fortum's power generation, physical operation and trading as well as expert services for power producers; Heat, consisting of combined heat and power generation; Russia; including power and heat generation and sales in Russia, and last division; Electricity Solutions and Distribution, which is responsible for Fortum's electricity sales and distribution activities.

The Company operates through more than 60 subsidiaries and is mainly active the Nordic countries, the Russian Federation, the Baltic States, Poland and the United Kingdom. As of December 31, 2011, the Finnish State held a 50.76% stake in the Company, which makes it similar to the situation in DONG Energy where the Danish state has a major stake. Fortum was created through a merger of the former Finnish state owned power company IV Oy and Finnish national oil company Neste Oy in 1998.

Source: http://www.fortum.com/en/pages/default.aspx

Iberdrola (IBE-MC)

Iberdrola SA is a Spain-based company engaged in the energy sector. Its main activities include the provision of services related to the production, transmission and distribution of electric power and its by-products. The Company is also involved in the real estate operations, as well as engineering and construction activities. The Company is a parent of Group Iberdrola and through its subsidiaries is present in approximately 40 countries, including Spain, Portugal, the United Kingdom, Germany, France, Italy, Greece, Russia and the United States among others.

Source:
http://www.iberdrola.es/webibd/corporativa/iberdrola?IDPAG=ENWEBINICIO&codCache=13680299613811209

RWE AG (RWE-XE)

RWE AG is a German electricity and gas company. It diversifies its activities into business areas such as; Power Generation and Sales, Renewables, Upstream Gas and Oil, and Trading/Gas Midstream and heat and energy services. The company mainly operates in Europe and has subsidiaries in the following countries Germany, Netherlands/Belgium, UK, Poland, Hungary, Turkey, Slovakia and the Czech Republic. The Renewables division comprises all of the activities of RWE Innogy, which specializes in electricity and heat generation from renewables. The Upstream Gas & Oil division produces gas and oil through RWE Dea. The Trading/Gas Midstream division encompasses energy trading, gas midstream activities, and sales to German clients. RWE is the second largest energy producer in Germany.

Source: http://www.rwe.com/web/cms/en/8/rwe/

Appendix 8: Subsidies in Countries of the Renewable Energy Peer Companies

France

France as well has a feed-in system in place. During the first ten years an offshore electricity producer get 8,52 €c /kWh and after 10 years the base rate will be adjusted to the number of production hours of the farm but it is possible to get the same amount as during the first ten years. In addition are the net-operators and other private electricity distributors required to purchase electricity generated by power plants using renewable energy sources at a rate se by decree.

Source: (Theolia Annual Report 2012).

Germany

In Germany there is a new Renewable Energies Law (EEG) since 2012, which aims to assure the continuous development of wind power investments. The payment for electricity is regulated in a feed-in system. The levels of payments varies dependent upon the circumstances. But for offshore wind farms there will be start-up payment of 15 cents/ kWh for a period of 12 years. Alternatively the operator can get a payment of 19 cents /kWh for a period of 8 years. However, the definite level of payment depends on the water at site and the distance from coastline. Another effect of the new law is that small renewable energy plant operators receives a 20 year guaranteed payment for their produced electricity. For onshore wind the country uses a feed-in tariff where the remuneration is set to 101.3 €/MWh.

Source: http://www.wind-energie.de/en/policy/renewable-energy-act

Italy

In Italy they have regulations on incentives for production of electricity from renewable sources. Among the incentives the CIP 6/92 is one the most important. The system offers a direct incentive to producers of renewable energy, whereby the producers could sell energy at a fixed price without participating in the feed in tariff market mechanism. Under the criteria “avoided costs” incentives where higher cost incurred by generating electricity from renewables are compensated for 8 years. Italy do also have other incentive systems that is provided for up to 15 years within a system of Green certificates and the alternative All-in rate that is a premium tariff provided for plants with an annual capacity above 1 MW. The All-in rate for offshore wind is 0.04€/kWh and last for up to 25 years. The base tariff, which is for the most part actually the maximum tariff, is divided into different levels depending upon the capacity. If the capacity is >1kW<20kW the amount of the tariff is 0.291€/kWh and the tariff for capacities > 5000kW is 0.165 €/kWh. The type of the tariff varies depending upon the capacity but is defined as either all-inclusive tariff or premium or premium with tender if the final price is awarded through a bidding process, which is the case if the capacity is greater than 5000kW. The country has recently adopted a system of feed-in tariffs for wind power and the system introduced can be considered as more complex and detailed compared to most of the other European countries.

Source: http://www.wind-works.org/cms/index.php?id=199&tx_ttnews%5Btt_news%5D=2071&cHash=e89c4c7348b9f9e2040552448af1839f

Spain

The regulatory framework for the wind sector in Spain also contains subsidies. Under the Directive 2001/77/EC, the country has a target that 29% of gross energy consumption should be produced form renewable energy. Further they have different Decrees established that the electricity generated could be sold at a price compricing a fixed element and a variable element depending on the energy prices in the market. For example does the 2007 Royal Decree maintains the feed-in tariff regime, which is subject to a floor and cap to unsure wind farm owners are not under or over remunerated. The incentives for renewable energy production was suspended 2012, which indicates that the country will continue to subsidy the renewable energy production.

Source: http://www.eref-europe.org/attachments/article/77/EREF-Price-Report-2012.pdf

UK

In the UK the Government has a target to achieve 30% of its energy consumption from renewable sources by 2020 in line with the European Union Directive. In order to reach the goals there are two incentive schemes in place: The NFFO order and the Renewables Obligation Order. The NFFO order implies incentives in so called NFFO a contract that in conclusion implies fixed price long-term sales contracts. The Renewables Obligation order works different but it also aims to promote and support renewable energy generation and subsidies are generated through different certification systems. The certificates are traded at a premium compared to the market price via a feed in premium mechanism.

Sources:
http://www.ofgem.gov.uk/Sustainability/Environment/NFFOSRO/Pages/NFFOSRO.aspx
http://www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/Pages/RenewablObl.aspx
https://www.wind-watch.org/news/2013/06/28/investment-in-renewables-may-get-hit-despite-rise-in-wind-farm-subsidies/

Summary of wind power production subsidies in the home countries of the peer companies used in the beta estimation procedure.

Country	Remuneration	Support Level	Duration (years)
DE	Offshore € 0.15/kWh first 12 years then base tariff of € 0.35/kWh onshore € 0.89/kWh first 5 years and then € 0.47/kWh	Government	Onshore and Offshore, Up to 20
DK	€ 0.366/kWh + Electricity price, offshore uses a bidding procedure.	Government	Onshore and Offshore 10-20
ES	€ 0.6792 - € 0.9427/kWh Depending upon time and capacity.	Government	Onshore Up to 25
FR	€ 0.853/kWh for 10 years onshore and then adjusted after hours of production. Up to € 13/kWh offshore depending upon production.	Government	10+ onshore 20 years offshore
IT	€ 0.127 - € 0.291/kWh Depending upon the specific project.	Government	Onshore 20-25
UK	Currently; Up to 5 MW € 0.061- € 0.446/kWh After 2014; Draft GBP 155/MWh offshore (GBP 135/MWh 2018) and GBP 100/MWh onshore (GBP 95/MWh 2018). Old renewable act (RO) run until 2017 and generate about GBP 130/MWh Offshore and GPB 90/MWh onshore	Government	20

Source: Own based on information from European Renewable Energies Federation asbl http://www.eref-europe.org/attachments/article/77/EREF-Price-Report-2012.pdf but also from sources referred to for each separate country.

Appendix 9: Hybrid Financing

The aim of hybrid capital is to combine benefits from different financial instruments and in general, hybrid securities therefore contains characteristics from both debt and equity. The structure of hybrid instruments can also get so complicated that it is hard to define them as either debt or equity. The aim is to treat expenses of payments for hybrid capital as dividends for financial reporting purpose but as interest for tax reporting purposes since interest payments are subject to deductions for tax reporting purpose (Engel, et al., 1999).

Hybrid capital treatment according to IAS 32 for Financial Instruments

”…The objective of this Standard is to establish principles for presenting financial instruments as liabilities or equity and for offsetting financial assets and financial liabilities. It applies to the classification of financial instruments, from the perspective of the issuer, into financial assets, financial liabilities and equity instruments; the classification of related interest, dividends, losses and gains; and the circumstances in which financial assets and financial liabilities should be offset…”

”…The issuer of a financial instrument shall classify the instrument, or its component parts, on initial recognition as a financial liability, a financial asset or an equity instrument in accordance with the substance of the contractual arrangement and the definitions of a financial liability, a financial asset and an equity instrument. The issuer of a non-derivative financial instrument shall evaluate the terms of the financial instrument to determine whether it contains both a liability and an equity component. Such components shall be classified separately as financial liabilities, financial assets or equity instruments…”

Source of Citations: (http://www.ifrs.org/Documents/IAS32.pdf) 2013-07-10

Appendix 10: Definitions Used by Thomson One, Worldscope

Total Debt: all interest bearing debt and capitalized lease obligations. It is the sum of long and short-term debt.

Beta*:* is measure of the company´s common stock price volatility relative to the market. This is the slope of the 60-month regression line of the percentage price change of the stock relative to the percentage price change of the local index.

Enterprise Value: is Market Capitalization Consolidated (as of close prior business day) + Preferred Stock + Minority Interest + Total Debt – Cash. (Cash, Preferred Stock, Minority Interest, Total Debt are from the latest interim).

EBITDA/FY1: is taken from the current forecasted estimate from IBES for EBITDA one year forward.

EBITDA/TTM: the last twelve months earnings of a company before interest expense, income taxes and depreciation. It is calculated by taking the pre-tax income and adding back interest expense on debt and depreciation, depletion and amortization and subtracting interest capitalized.

Appendix 11: Simulation Descriptive Statistics

NPV

DKK million	Project A	Project B
Minimum	-5 595	-9 681
Maximum	5 991	8 762
Mean	1 329	1 949
Standard Deviation	1 370	2 031
Median	1 373	2 056
5 % percentile	-1 002	-1 500

IRR

Percent	Project A	Project B
Minimum	-2.39	-3.38
Maximum	10.96	13.39
Mean	6.38	7.00
Standard Deviation	1.48	2.14
Median	6.46	7.18
5 % percentile	3.82	3.26

Appendix 12: Questionnaire used for the semi structured Interviews

Questionnaire used for the interview with Andreas Nahne Nickelsen.

1. Are you aware of other methods companies are using in order to incorporate project specific risk? For example when the project risk is different from the company risk?
2. With regards to the above, what the pros and cons are with these methods?
3. What are the general pros and cons with using MC simulation in DCF-valuation?
4. How has the use of MC simulation affected the requirement of time and other resource compared to the static valuation?
5. What other forms of risk analysis do you use as complementary methods for analyzing risk?
6. How has the decision making process been affected by the use of MC simulation?
7. What are the pros and cons, when communicating the results from a DCF based on MC simulation valuation to decision makers compared to static values?
8. How do you feel that the simulation-based approach to valuation has been accepted with respect to the increased need for statically knowledge?
9. How do you go on about choosing the type of distribution for the inputs?
10. How do you decide which inputs to be estimated as distributions rather than static values?
11. How has the quality of the input estimates changed since introducing this model?
12. Who is put responsible for making the model input estimates?
13. How has the general response been from affected persons within the organization when introducing this valuation methodology?
14. How do you feel that the attitude towards the new methodology differ between different levels in the organization e.g. between decision makers and the persons responsible for making the estimates?
15. When discounting the project cash flows, how do you go on about choosing the discount rate and beta?
16. Is this method applicable in every case, e.g. even if project faces different risk profiles?

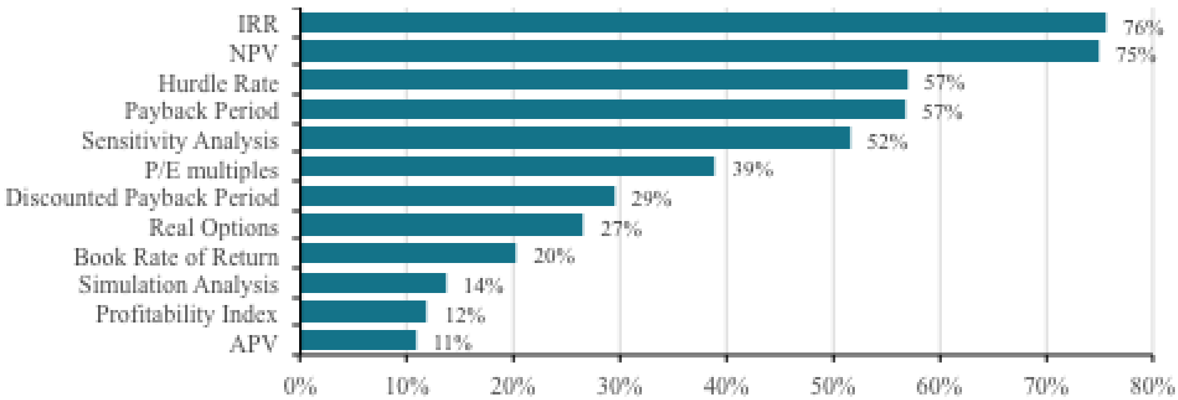
Questionnaire used for the interview with Emelie Zakrisson.

1. Are you aware of other methods companies are using in order to incorporate project specific risk? For example when the project risk is different from the company risk?
2. With regards to the above, what the pros and cons are with these methods?
3. How has the decision making process been affected by the use of MC simulation?
4. What are the pros and cons, when communicating the results from a DCF based on MC simulation valuation to decision makers?

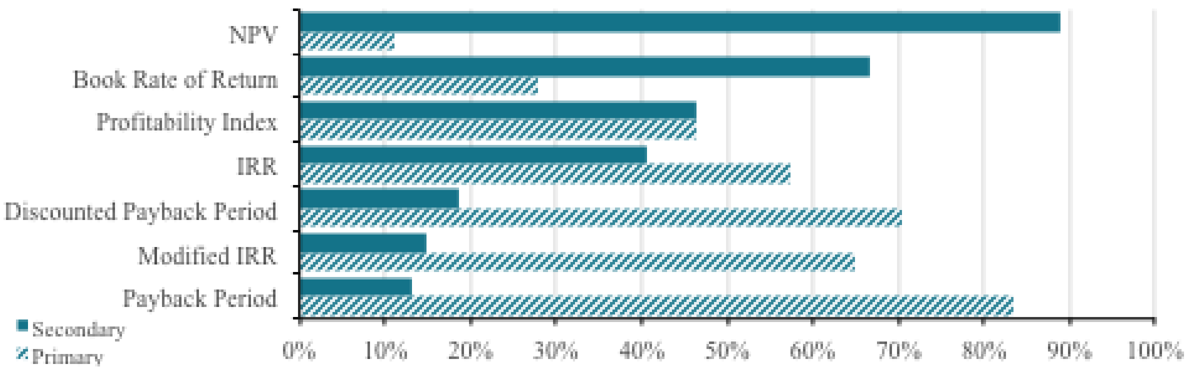
5. How do you feel that the simulation-based approach to valuation has been accepted with respect to the increased need for statically knowledge?
6. How has the introduction of Monte Carlo simulation affected the resource required for approximating the input estimates?
7. How do you go on about choosing the type of distribution for the inputs?
8. How do you decide which inputs to be estimated as distributions rather than static values?
9. How has the quality of the input estimates changed since introducing this model?
10. Who is put responsible for making the model input estimates?
11. How has the general response been from affected persons within the organization when introducing this valuation methodology?
12. How do you feel that the attitude towards the new methodology differs between different levels in the organization e.g. between decision makers and the persons responsible for making the estimates?

Appendix 13: Survey results from Previous Research

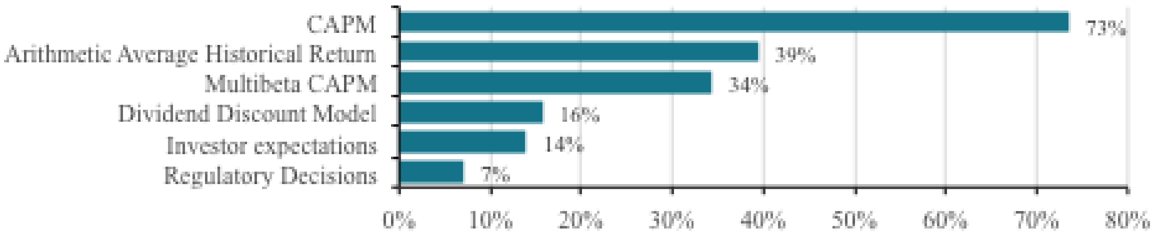
Result Summary from the Survey study undertaken by Graham and Harvey 2001 on US. Firms of which capital budgeting techniques they used for decision-making and analysis.



Result Summary from the Survey study undertaken by Chan et al 2001 on Chinese Companies. The respondents were asked to classify the popularity of appraisal methods among Chinese firms. The primary and secondary most popular method is presented in the table below.



Result from the Graham and Harvey (2001) Study concerning the techniques used to estimate the Return on Equity Capital based on 392 CFO answers of US. firms.



Appendix 14: CAPM Assumptions

1. No transaction costs.
2. All assets are diversifiable.
3. No personal income taxes.
4. Investment decisions are based on the expected return and standard deviation of a portfolio.
5. Unlimited short selling is allowed.
6. Actions undertaken by an individual cannot influence the stock prices.
7. Unlimited lending and borrowing at risk free rate.
8. Investors are assumed to be rational and having the same expectations and perfect information.
9. All kind of assets are traded on a well functioning market place.
10. Investors base their decisions based on mean and variance of expected returns.

Source: (Brealey, et al., 2011)