

NHH



Norwegian School of Economics

Bergen, Spring, 2017

Investment Analysis

Examining the Theoretical- and Practical Relationship

Mathias Bjørlo Fett and Eirik Aakvik Håland

Supervisor: Professor Øystein Gjerde

Master thesis, Business Analysis and Performance Management

NORWEGIAN SCHOOL OF ECONOMICS

This thesis was written as a part of the Master of Science in Economics and Business Administration at NHH. Please note that neither the institution nor the examiners are responsible – through the approval of this thesis – for the theories and methods used, or results and conclusions drawn in this work.

Preface

This Master thesis was written to conclude the Master of Science degree in Economics and Business Administration at the Norwegian School of Economics during the spring of 2017. We have specialized in Business Analysis and Performance Management and have used this spring to deep dive into capital budgeting practices.

Capital budgeting decisions involve large sums of money with significant impact on the investing firms and the economy as a whole. For this reason, companies are continuously confronted with the dilemma if the use of a specific resource is worthwhile in terms of benefits.

When considering an investment, practitioners use analyzes based on their own subjective assumptions regarding input, growth, risk and cash flows. However, each of these variables contain several assumptions made with management discretion. For instance, a small change in the growth variable can change the value of a project substantially. Over time, managers have used various commonly taught capital budgeting models and cost of capital estimation procedures. Nonetheless, the use of these models has not always aligned with what is taught in finance theory.

“In theory, there is no difference between theory and practice. In practice, there is”

Walter Savitch (1984, p. 7)

Dedicating time and focus on the underlying assumptions and inputs of an analysis often benefits a company significantly when deciding which project to- accept and which to reject. Thus, our aim has been to investigate whether practitioners deviate from theoretical standards by looking at one specific investment analysis.

We wish to thank our supervisor, Professor Øystein Gjerde for helpful discussions and guidance throughout the semester. We would also like to express our gratitude to Company X for providing us with relevant data and industry insight.

Abstract

Previous studies on the topic of theory versus practice are usually conducted using surveys, with extensive questionnaires addressed to CEOs from different companies. This give rise to aggregated results, primarily focusing on the different methods companies use. As opposed to the survey approach, this thesis aims to investigate the assumptions underlying the inputs and thereby capture a more detailed image on theoretical and practical differences.

The purpose of this thesis is to provide a comprehensive- and in-detailed study of an investment decision involving a wind farm project made by Company X. This specific project is analyzed solely based on a theoretical approach in terms of methods and assumptions. Moreover, the methods and assumptions applied by this thesis are extensively discussed against the methods and assumptions made by Company X.

The power industry distinguished itself as being a unique industry in terms of vital governmental subsidies and distinctive dynamics regarding the supply- and demand of power. This contribute to the fact that decoupling from aggregated studies is a necessity to conceive more relevant results.

The thesis finds that Company X's investment analysis had a strong link with the theoretical foundation, which was in contrast to our first assumption, that there would at least be some significant gaps between the theoretical- and practical approach. However, there are two findings that we find especially interesting.

First, the cost of capital estimated in this thesis is relatively lower than the utilized cost of capital of Company X. This is not necessarily a breach between theory and practice, but rather a matter of what relevant risk is considered to be. This correspond with findings from other theory- and practice surveys - that many firms use the total firm risk rather than project risk in assessing new investments. Second, the analytical results illustrate deviant objectives in terms of reflecting the true project value. We observe a weak tendency towards making the project as profitable as possible, as opposed to identifying the actual value creation of the project.

Table of Contents

1.	Introduction.....	1
1.1	Background.....	1
1.2	Purpose of the Thesis.....	2
1.3	The Wind Farm Project.....	2
1.4	Structure of the Thesis.....	3
2.	Theory & Methodology.....	4
2.1	Methodology.....	4
2.1.1	Data.....	5
2.2	Theory.....	7
2.2.1	Discounted Cash Flow (DCF) Model.....	7
2.2.2	Capital Asset Pricing Model (CAPM).....	8
2.2.3	Weighted Average Cost of Capital (WACC).....	10
2.2.4	Real Options.....	11
3.	Strategic Analysis.....	14
3.1	Value Creation in the Power Market.....	14
3.2	The Power Market.....	17
3.3	Opportunities and Threats.....	22
4.	Analysis.....	25
4.1	Revenue.....	25
4.1.1	Simulating the System Price.....	25
4.1.1.1	Volatility Forecasting, GARCH (1.1).....	30
4.1.1.2	Monte Carlo Simulation.....	32
4.1.2	Simulation of Green Certificate Prices.....	35
4.1.3	Production Volume.....	39
4.1.4	Theory versus Practice on Revenue.....	39
4.2	Costs.....	41
4.2.1	Two Perspectives on Depreciation Costs.....	43
4.3	Working Capital.....	45
4.4	Free Cash Flow to Firm.....	46
4.5	Cost of Capital.....	47
4.5.1	CAPM.....	47

4.5.1.1 Beta	48
4.5.1.2 The Market Premium	51
4.5.1.3 The Risk-free Rate	52
4.5.2 WACC	53
4.5.3 The Approach to Cost of Capital	55
4.6 Net Present Value	56
4.7 Sensitivity Analysis.....	56
4.7.1 Simulation of the Project	60
4.8 Real Options	63
5. Analytical Findings	66
5.1 Introduction.....	66
5.2 Revenue.....	67
5.3 Costs	68
5.3.1 Marginal Loss.....	69
5.3.2 Depreciations.....	70
5.4 Cost of Capital.....	72
5.4.1 Why Cost of Capital Deviates.....	72
5.5 Rationality	77
5.6 Comparing Findings with Previous Research	78
6. Conclusion	80
7. References.....	81
APPENDIX 1:.....	90
1.1 Questionnaire to the Project Manager.....	90
APPENDIX 2:.....	92
2.1 Extended Theory on Real Options.....	92
2.2 Extended Theory on Opportunity Cost of Capital	94
APPENDIX 3:.....	95
3.1 Complementary Sensitivity Inputs	95

List of Tables

TABLE 1: SUMMARY STATISTICS OF MONTHLY AND ANNUAL PRICES	6
TABLE 2: ILLUSTRATION OF HOW THE POWER MARKET DISTRIBUTES POWER FROM THE MANUFACTURES TO THE RECEIVING HOUSEHOLDS AND INDUSTRIES	17
TABLE 3: GARCH PARAMETERS, WHERE $\alpha_0, \alpha_1, \alpha_2$ ARE THE ESTIMATED WEIGHTS FOLLOWING FROM THE MAXIMUM LIKELIHOOD ITERATION	31
TABLE 4: EXHIBITS THE ESTIMATED FUTURE ANNUAL PRICES/MWH AND THE RESPECTIVE PRICE CHANGES. THE PROJECT PERIOD IS EXPECTED TO LAST FOR 23 YEARS (UNTIL 2038)	34
TABLE 5: EXHIBITS THE ESTIMATED FUTURE ANNUAL GREEN CERTIFICATE PRICES/MWH AND THE RESPECTIVE PRICE CHANGES. COMPANY X HAS THE RIGHT TO RECEIVE CERTIFICATES UNTIL 2030	37
TABLE 6: SUMMARY STATISTICS OF MONTHLY AND ANNUAL GREEN CERTIFICATE PRICES.....	38
TABLE 7: PRICES AND STANDARD DEVIATIONS USED AS INPUT IN THE SIMULATIONS. THE NOTATION BEHIND THE PRICES IS NOK/MWH	38
TABLE 8: OVERVIEW OF THE SIGNIFICANCE IN THE BETA ESTIMATES	50
TABLE 9: EXHIBITS THE PROCESS IN WHICH THE AVERAGE BETA WAS ESTIMATED.....	51
TABLE 10: EXHIBITS THE PROCESS IN WHICH THE AVERAGE MARKET PREMIUM WAS ESTIMATED	52
TABLE 11: ILLUSTRATES THE COST OF CAPITAL BASED ON THE THEORETICAL FRAMEWORK	54
TABLE 12: ILLUSTRATES THE VALUE OF THE PROJECT THROUGH BOTH THE THEORETICAL- AND PRACTICAL APPROACH.....	56
TABLE 13: SUMMARY STATISTICS OF SIMULATED NPV.....	61
TABLE 14: EXPECTED NPV BASED ON THREE DIFFERENT SCENARIOS AND THEIR RESPECTIVELY PROBABILITIES.....	62
TABLE 15: ADVANTAGES AND DISADVANTAGES BY USING STRAIGHT-LINE DEPRECIATIONS	70

List of Figures

FIGURE 1: LOGNORMAL DISTRIBUTION OF ELECTRICITY PRICES OVER THE LAST 15 YEARS	5
FIGURE 2: THE DISTRIBUTION OF LOGARITHMIC PRICE CHANGES.....	6
FIGURE 3: SUPPLY AND DEMAND OF ELECTRICITY CAPTURE THE SYSTEM PRICE IN EQUILIBRIUM.....	15
FIGURE 4: EXCERPT OF COMPANY X'S VALUE CHAIN.....	16
FIGURE 5: THE DISTRIBUTION OF LOGARITHMIC PRICE CHANGES.....	26
FIGURE 6: MONTHLY ELECTRICITY PRICES/MWH OVER THE LAST 15 YEARS.....	26
FIGURE 7: MONTHLY ELECTRICITY PRICES/MWH WITH HODRICK-PRESCOTT FILTER OVER LAST 15 YEARS	29
FIGURE 8: FORECASTED MONTHLY VOLATILITY ON FILTERED ELECTRICITY PRICES USING GARCH (1.1).....	31
FIGURE 9: AN EXCERPT OF THE PRICE PATH FROM 1000 SIMULATIONS.....	32
FIGURE 10: ILLUSTRATES 200 SIMULATIONS WITHIN YEAR 2020	34
FIGURE 11: MONTHLY GREEN CERTIFICATE PRICES/MWH OVER THE LAST 15 YEARS.....	36

FIGURE 12: FORECASTED MONTHLY VOLATILITY ON GREEN CERTIFICATE PRICES USING GARCH (1.1) 36

FIGURE 13: AN EXCERPT OF THE GREEN CERTIFICATE PRICE PATH FROM 1000 SIMULATIONS 37

FIGURE 14: AN ILLUSTRATION OF DIFFERENT COST CLASSES AND THEIR RESPECTIVE SHARE OF TOTAL COSTS FOR 2017 41

FIGURE 15: AN ILLUSTRATION OF THE TWO DIFFERENT DEPRECIATION METHODS AND THE CONTRAST IN COST DISTRIBUTION 45

FIGURE 16: EXHIBIT OF THE DEVELOPMENT OF THE THEORETICAL- AND PRACTICAL CASH FLOW 46

FIGURE 17: EXHIBITS THE REGRESSION OF THE STOCK RETURNS AGAINST THE MARKET RETURNS 49

FIGURE 18: ILLUSTRATES THE NPV OF THE PROJECT THROUGH A SENSITIVITY ANALYSIS WITH DIFFERENT INPUTS OF OPERATING HOURS
..... 57

FIGURE 19: ILLUSTRATES THE NPV OF THE PROJECT THROUGH A SENSITIVITY ANALYSIS WITH DIFFERENT INPUTS FOR COST OF CAPITAL
..... 58

FIGURE 20: THE CASH FLOW DEVELOPMENT OF BOTH COMPANY X AND THE THEORETICAL APPROACH, USING TAX DEPRECIATIONS . 59

FIGURE 21: THE CASH FLOW DEVELOPMENT OF BOTH COMPANY X AND THE THEORETICAL APPROACH, USING TAX DEPRECIATIONS
AND THE SAME PRICE ESTIMATIONS AS COMPANY X 59

FIGURE 22: EXHIBITS A NORMAL DISTRIBUTION FOR THE PROJECT'S NPV, BASED ON 1000 SIMULATIONS..... 61

FIGURE 23: ILLUSTRATES THE FORECASTED ELECTRICITY PRICE- AND GREEN CERTIFICATE PRICE DEVELOPMENT FOR THE TWO
DIFFERENT APPROACHES..... 68

1. Introduction

1.1 Background

Several research papers have been examining the relationship between the practical and theoretical application of capital budgeting. The common understanding from these papers is that management apply the basic models and assumptions in their analysis. However, it seems that they deviate from what may be their understanding of the theory when they apply the actual models onto a project.

For instance, Berg et al. (2013) did a survey on the 500 largest companies in Norway, with the purpose to shed light on how Norwegian companies perform their investment analysis. They observe less differences between how other countries practices than between theoretical and practical approaches. In other words, companies are behaving in roughly the same manner across borders. Furthermore, the paper reveals that the net present value (NPV) method was preferred, followed by the payback method. Companies also commonly use the WACC, followed by experience and common sense.

An investment analysis is quite often backed up with a sensitivity analysis as an auxiliary method, and 57 % of the respondents from the survey state that they always- or almost always use auxiliary methods to strengthen their analysis. The survey recognizes the fact that the use of real options is almost non-existent and points to two reasons as to why that may be. First, the method is difficult to implement due to the uncertainties underlying the inputs. Second, decision-makers do not have the right knowledge to determine how to apply this method (Berg et al. 2013). If academia assist practitioners to implement theoretical founded models, it could give Norwegian businesses a competitive advantage at a heightened level of precision regarding projects that are accepted or rejected (Berg et al. 2013).

Another study conducted by Graham and Harvey (2001) found that the DCF model was widely used in conjunction with the Capital Asset Pricing Model (CAPM), although more than half of the respondents would use their company's overall discount rate to evaluate a project in a foreign market. This, despite the threat of different risk attributes, which reveal that practitioners might apply the CAPM or NPV- rule incorrectly (Graham and Harvey, 2001).

1.2 Purpose of the Thesis

This thesis aims to examine the relationship between how an investment is done in practice and how it may deviate from textbook standards. The purpose is to assess an investment decision done by Company X, against established research and discuss any substantial differences that may arise. By using real investment decisions from Company X as an objective to be analyzed, different aspects will be discussed, compared and analyzed extensively.

A typical problem that arises when valuing a project is managing the uncertainty of risk in the cash flows. This is also where the methods used in the analysis tend to differentiate between theory and practice. The purpose is to see if different choices and other assumptions will in fact change the investment decision. Our hope is that this thesis will facilitate a different approach to the research on the gap between theory and practice.

1.3 The Wind Farm Project

Company X is a Norwegian power company specialized in production and distribution of renewable energy, such as hydropower and wind power. Five main business areas unite the organization, although the core business lies within the production department. This department deals with the operating services within every renewable energy source, and the access to these natural resources are vital for the overall value creation of the company. (Company X, 2017b).

The project to be analyzed is a wind farm investment, strategically located at the coastline of Norway. In total, there is set to be five modern wind turbines, each delivering an effect of 3 megawatt (MW). Put into perspective, each turbine has an hourly effect that exceeds the yearly consumption of a Norwegian family of four (Hafslund, 2017a). A wind farm of this size is expected to last between 20-25 years, but since the Norwegian government give concession rights for a total of 25 years it is desirable to strive for 25 years of production.

Wind power is highly dependent on the weather conditions in order to generate power, and the installations are categorized by a large upfront investment expenditure. In general, wind is impossible to control and for this reason, the installations generate as

much electricity as the weather allows (Vindportalen, 2017). That being said, Norway has a huge amount of unused wind resources. Thus, it represents a good base for wind power investments, which in turn will create attractive jobs outside the major cities and contribute positively to the community (Statkraft, 2017).

1.4 Structure of the Thesis

To be able to substantiate our findings it is necessary to illustrate and explain theories and models used in a transparent way. When comparing an actual investment analysis with the theoretical approach, it is appropriate to build a good foundation for the discussions to come. Our research question will be presented in section 2, together with necessary data and thoroughly explained methods to better understand the thesis as a whole.

As any investment analysis, it is utterly important to connect it with the overall strategic analysis. Section 3 highlights the value drivers and distinct characteristics of the market Company X operates in. The specific investment, external factors and competitive advantage is carefully studied to assess the strategic link. Finally, Company X's opportunities and threats are highlighted to give an indication if real options can be used to capture flexibility in the future.

Section 4 concerns the actual investment analysis this thesis builds upon. A vital part of Company X's industry is to predict the future price of electricity and electricity certificates (green certificates). Underlying volatility forecasting and simulations are applied to better understand the magnitude of price uncertainty. Furthermore, operating costs and cost of capital are described in detail. Each subheading will discuss the differences from theoretical and practical approach as they come to light.

In section 5, the findings from our analysis will be discussed and thoroughly assessed against previous research on the theory-practice gap. The focus will be set on key characteristics that differentiates the theoretical analysis by this thesis and the practical analysis constructed by Company X.

2. Theory & Methodology

2.1 Methodology

This thesis will make use of a concurrent mixed method research, which involves the separate use of quantitative- and qualitative methods within a single phase of data collection and analysis. This allows both sets of results to be interpreted simultaneously to provide a richer and more comprehensive response to the question at hand (Saunders et al. 2016, p. 170):

“Are there significant deviations between how an investment analysis is done in practice, and how the theory states it should be done?”

The thesis will assess different assumptions and qualitative decisions made by Company X and evaluate how these assumptions are applied in quantitative models with a theoretical approach as a framework of discussion. The design is built as an evaluative research with the aim to gain insights into how Company X conducts their investment analysis and assess how- and why different assumptions are made. The advantage of this approach is that the theoretical contribution can help understanding, not only the effectiveness, but also compare explanations to existing theory (Saunders et al. 2016, p. 176).

To be able to answer the question at hand we will assess Company X’s project using the Weighted Average Cost of Capital (WACC) method, complemented with a sensitivity analysis, simulations and real option opportunities. These models will contribute to investigate the following:

- Are there significant deviations between assumptions made by Company X and what the theory suggests?
- Given significant deviations, will this impact the investment decision?
- Will implementation of real options create additional value?

2.1.1 Data

Research often distinguish between primary- and secondary data. Primary data are information gathered for our own purposes, while secondary data are information that primarily have been used for other purposes (Gripsrud et al. 2010, p. 58-71).

In this thesis, the qualitative- and quantitative primary data were gathered both from conversations and from a data set given to us by the project manager in Company X. The conversation was based on a questionnaire prepared by us, which is exhibited in appendix 1. This information covered the specific project in terms of important assumptions, model characteristics and relevant market inputs that affect the company. The secondary data are primarily quantitative, as inputs in the analysis are considered to be a comparative foundation to assess company X's project up against theory. Thus, literature refer to this as time-series data collected over discrete intervals of time. Examples of such data include the monthly price of- electricity in Norway and the Hafslund stock prices, as well as S&P 500 and OSEBX. The key feature of time-series data is that the same economic quantity is recorded at a regular time interval (Hill et al. 2012, p. 7).



Figure 1: Lognormal distribution of electricity prices over the last 15 years

The thesis uses a data set consisting of electricity prices obtained from Nord Pool power exchange on 15. February 2017, with historical monthly prices ranging between January 2000 and January 2015 (Nordpoolspot, 2017a). The purpose of this data set is to simulate future electricity prices based on a Monte Carlo simulation. As figure 1 illustrates, the distribution of these prices is lognormal, which means that the natural logarithm of one-

plus-the-price change between time- t and Δt is assumed to be normally distributed with mean μ and standard deviation σ (Benninga, 2014, p 681).

Table 1 summarize the statistics of electricity prices the last 15 years in a monthly and annual frequency. The skewness is the measure of symmetry in the distribution of price changes and the kurtosis measure the thickness of the distribution's tail. The larger the tail the greater the probability of extreme events in the data.

Summary Statistics Electricity price		
	Monthly	Annual
Mean	0,36 %	4,38 %
Std dev	19,0 %	65,8 %
	LN % change	Price
Max	56,29 %	777,57
Min	-68,22 %	42,05
Median	-0,56 %	268,27
	LN % change	
Skewness	-0,146	
Excess Kurtosis	1,685	

Table 1: Summary statistics of monthly and annual prices

A normal distribution has a skewness of 0 and kurtosis of 3, while the skewness obtained from the historical electricity prices are negatively skewed (-0.146), with an excess kurtosis of 1.685 . This means that the price data have a kurtosis of 3 plus 1.685 in excess of a normal distribution.

As observed from figure 2, the logarithmic changes are approximately normally distributed with a mean of 0.36 and standard deviation of 0.19 .

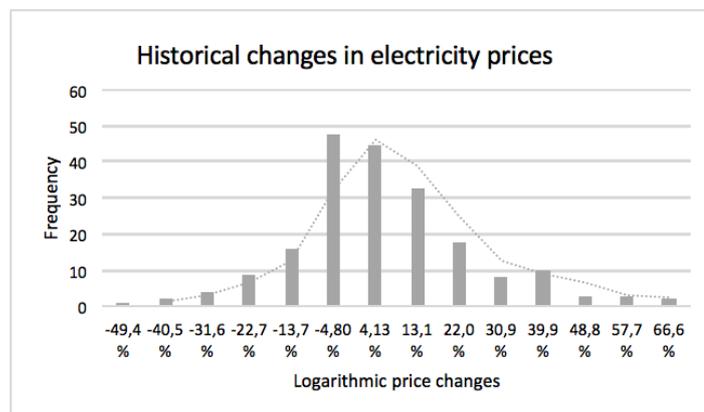


Figure 2: The distribution of logarithmic price changes

2.2 Theory

Before we start analyzing the specific wind farm project, theory behind relevant methods will be introduced to better understand the valuation process underlying the analysis. The methods will be presented and explained, together with their strengths and weaknesses. Inputs needed to compute the models will be discussed and dealt with throughout the analysis in section 4.

2.2.1 Discounted Cash Flow (DCF) Model

DCF is a widely used model for evaluating projects with large capital expenditures. The model determines the present value (PV) of future cash flows by discounting them, using an appropriate cost of capital (Yang and Blyth, 2007). Equation 1 illustrates the relationship between future cash flows and the present value, and states that the present value is a function of the sum of future cash flows during a period, discounted back to the present with a risk-adjusted discount rate. This reflects the concept, *time value of money*, which provides compensation for delayed consumption, expected inflation and the level of risk (Wahlen et al. 2012, p. M-3).

$$PV = \sum_{t=1}^T \frac{CF_t}{(1+r)^t} \quad (1)$$

Cash flows in different time periods cannot be directly compared, for this reason, investors prefer to get money sooner rather than later. This logic applies to the difference between certain and uncertain cash flows, due to the opportunity cost and the uncertainty over time. It is difficult to estimate an appropriate cost of capital, especially in smaller firms, whom stocks are not traded in the market. An argument made by users of this method is that the discount rate will be raised to control for uncertainty. However, it is hard to justify to which level the discount rate will incorporate all future risks (Yang and Blyth, 2007).

The cash flows will vary from asset to asset and for this reason, the DCF model can be interpreted as an act of faith. A common belief is that every asset has an intrinsic value, and the purpose is to estimate that value by looking at an asset's fundamentals. Intrinsic

value can be defined as the value attached to an asset by an analyst with access to all information available right now and the use of a perfect valuation model. This is however rarely the case, but every analyst strives to be as close to the *perfect analyst* as possible. The problem lies in the fact that none of us is ever going to know the true intrinsic value of an asset, meaning that perfect accuracy in the DCF model is not possible (Damodaran, 2008, p. 100).

This thesis will apply various auxiliary methods in order to estimate the cash flow based on advanced econometric tools defined as Hodrick-Prescott-filter, GARCH 1.1 and an AR(1)-process. These methods will be thoroughly explained in section 4, and assist the DCF-method in yielding a more convincing future cash flow estimate.

2.2.2 Capital Asset Pricing Model (CAPM)

The purpose of the CAPM is to price an asset in equilibrium and reward investors for less risk by being diversified. In the CAPM it is assumed that all investors have the same beliefs and seek mean-variance efficiency. It follows that all investors mix the same portfolio of risky assets, which must in fact be the market portfolio. Given this assumption about the CAPM, the market is an efficient portfolio, and there is a linear relation between the expected return of each security and its regression against the market (Markowitz, 2008).

The CAPM became a revolutionary tool in capital budgeting in regards to recognizing that the risk of an asset was not how it behaved in isolation, but how the asset moved in relation to other assets and the market itself (Ang, 2014, p. 196).

In the development of the CAPM, Sharpe and Lintner added a riskless asset to the mix and concluded that there existed an alternative, which was superior to investors at every risk level. This, created by combining the riskless asset with a supremely diversified portfolio on the efficient frontier. This generated a higher expected return for every given level of risk, as opposed to just holding a portfolio of risky assets (Damodaran, 2008, p. 77).

There are several assumptions behind the CAPM. The model assumes no transactions costs or taxes, and it is given that investors have identical information about assets. In

addition, all investors must share a single period time horizon and borrow-/invest at a risk-free rate. It follows that the model eliminates any rationale for holding back diversification. Under which we accept these assumptions, the risk of an individual asset becomes the risk added on to the market portfolio. This can be measured statistically as illustrated in equation 2. The risk of an asset is given by β , which is a function of the covariance of the asset with the market portfolio, scaled by the variance of the market (Damodaran, 2008, p. 78).

$$\beta = \frac{COV(r_i, r_m)}{Var_m} \quad (2)$$

The assumptions constraining the CAPM may not seem feasible in the real world. However, it is the most commonly used model in estimating expected return on a stock ($E(r)$). The formula of the CAPM is given by equation 3. The riskless rate of return is given by rf , and the expected return on the market portfolio is given by $E(r_m)$, yielding $(E(r_m)-rf)$, the market risk premium.

$$E(r) = rf + \beta(E(r_m) - rf) \quad (3)$$

Before the CAPM, risk was often thought to be an asset's own volatility. In accordance with CAPM, this is irrelevant, since co-variation between an asset and the market is what matters. Andrew Ang state upfront that the CAPM is well known to be a failure. The model predicts that asset risk premiums only depend on the asset's beta, and that there is only one factor that matters, the market portfolio. Both predictions have been refuted in several empirical studies. However, the basic intuition of CAPM holds true, that the factors underlying the assets determine asset risk premiums and that these premiums are compensation for losses during bad times. Even though the CAPM has been rejected by data, it continues to be the model used in finance. 75 % of finance professors advocate it, and 75 % of CEOs employ it in capital budgeting decisions even though it does not hold (Ang, 2014, p. 197).

2.2.3 Weighted Average Cost of Capital (WACC)

When conducting a real investment analysis, companies often tend to estimate expected cash flows generated from the project, to the firm-, debt- and equity. This implies that firms need a model that determines the market value of a project's levered cash flows correctly (Miles and Ezzell, 1980).

With no debt, the pretax WACC unlevered is equal to the equity cost of capital. As the firm increases its debt, the equity cost of capital rises, which follows by the notion that the risk in the equity increases as the debt increases. Consequently, the equity holders must be compensated. However, the net effect yields that pretax WACC remains constant, because more weight is put on the cost of debt, which is relatively lower than the cost of equity. As described by Miller and Modigliani's propositions, the pretax WACC equals the unlevered cost of capital, which is the average return that a firm must pay to its investors, both equity- and debt holders. (Berk and DeMarzo, 2014, p. 491-514).

In a real world one cannot do business without paying taxes. However, the tax-deductibility of interest payments lowers the effective after-tax cost of debt. The WACC represents the effective cost of capital to the firm after including the benefits of the interest tax shield. It will therefore be lower than the pretax WACC when debt increases. The more the firm exploits the advantage of debt, the lower the WACC becomes.

A capital budgeting model, should not only account for the effects of the investment decision, but also those of the financing decisions and the interaction between the two. To reflect the combined effects of both the investing- and financing decision, the cash flows will be discounted at a rate specified as a weighted average of the firm's after-tax costs of debt and equity. This is generally known as the *textbook approach* (Miles and Ezzell, 1980).

Equation 4 illustrates the WACC, where debt and equity is scaled by their weights in the total firm value, debt plus equity. r_E is denoted as the cost of equity, r_D is the cost of debt and τ is the corporate tax rate. This approach has become popular mainly due to two factors. First, if the project is of the same risk class as the firm's existing portfolio of projects, the cost of equity- and debt can be estimated by observing market rates of return on the firm's securities. Second, the managers can operate with one single discount rate,

which does not only reflect the operating risk in the projects, but also the financing policies. In turn, this discount rate is used to evaluate the firm's investment opportunities (Miles and Ezzell, 1980)

$$r_{WACC} = \frac{E}{E + D} * r_E + \frac{D}{E + D} * r_D * (1 - \tau) \quad (4)$$

The WACC is widely used in corporate finance, but the correct calculation of WACC depends on a correct valuation of the tax shield. The tax shield in turn, rests on the debt policy of the company. There have been made several arguments in how to calculate the present value of the tax shield. Miller and Modigliani argue that a fixed debt level indicates that the tax shield should be discounted using the required rate of return on debt. However, if the leverage ratio is fixed at market value, Miles and Ezzell argue that the tax shield should be discounted by the required return on debt in the first period, and by the asset rate of return in subsequent periods (Fernandez, 2007).

Estimating the cost of equity through the CAPM and have it function as an input in WACC together with the cost of debt, provides the needed risk-adjusted rate to discount the future cash flow. This will be applied during the analysis in section 4.5. Furthermore, appendix 2.2 contains the theory on the principle of opportunity cost, meaning that the cost of capital functions as the cost of missing the opportunity to invest in other projects.

2.2.4 Real Options

An investment project often has multiple opportunities to reassess the value as new information arises over time, for instance, adjust or abandon established plans. Myers (1977, referenced in Barnett 2008, p. 607) referred to these unfolding decision-making opportunities as real options. This because they involve real assets, which have financial option-like characteristics in that they provide the right not the obligation to act (Barnett, 2008).

Under real options reasoning, high risk becomes one of the best reasons to preserve and not reject a project (Barnett, 2008). This follows the logic from a financial option, where

high volatility increase the value of the option because the potential gains are greater while the costs remain the same (McGrath, 1999).

Academics and managers have been dissatisfied with the inability of conventional capital budgeting techniques to capture the strategic aspect of projects. DCF for instance, ignore the flexibility that gives managers the option to revise decisions while a project is underway. A decision to invest immediately calls for a sacrifice of the option to wait and see, and the loss of this option value must be treated as an investment cost (Trigeorgis, 1995, p. 89-90).

The value of real options origin from the fact that when investing in risky assets, we learn from observing the real world. We adjust our behavior to increase our potential upside from the investment and decrease the possible downside. In this framework, we act on updated information to expand opportunities simultaneously as we reduce the danger. The value of learning is at the greatest when we are the only ones to have access to it (Damodaran, 2008, p. 231-233).

The correct valuation of a project requires an expanded NPV rule, which encompass both the value of the project using conventional NPV and the value component of the management flexibility (Trigeorgis, 1993).

Expanded NPV = NPV of the project + Value of real option (flexibility)

It is important to consider the scope of investment opportunities, possible access to avenues of growth or variance underlying such investments. An increase in scope of the opportunity is represented by the volatility of the stock on which an option contract is written, which leads to an increase in option value. The reason for this occurrence is because the investment in the option is fixed at the price of the option, giving investors access to a greater range of outcomes on the upside, while containing the downside. The real option analogue is that provided the downside loss an organization would sustain if it chooses to stop further investment in a technology area, is contained, its investment increase in value with increases in variance of results (McGrath and Nerkar, 2004).

McGrath and Nerkar, (2004), believe that real option reasoning can explain some of the differences between actual managerial investment behavior and theorized investment behavior. However, in practice, few managers have the ability nor the desire to practice

the techniques needed to value a real option. The methods used to value real options are complex and each scenario may require its own set of complex calculations. Thus, few firms assess the value of their real options. On the other hand, many firms use real option reasoning to guide their strategic decision making, and take actions regarding their investment strategy, such that behavior is consistent with capturing the real option value (Barnett, 2008).

The use of real options is in many instances very useful, and may provide managers with valuable flexibility when a project is initiated. However, in this case we find that the use of real options is less beneficial, due to lack of flexibility in this specific project, which will be addressed in section 4.8. Additional real option theory will be provided in appendix 2.1.

3. Strategic Analysis

The strategic analysis intends to evaluate the market in which Company X operates and to identify key characteristics for future value creation. Furthermore, the thesis will examine the position and opportunities Company X may have in the production and sales of electricity generated from wind power. In order to make $NPV > 0$ one must optimize the numerator and denominator of the following equation:

$$PV = \sum_{t=1}^T \frac{CF_t}{(1+r)^t}$$

CF is the cash flow and k denotes the risk adjusted cost of capital. In this section, the focus is set on how internal- and external strategic factors will affect the cash flows. The cost of capital will be discussed thoroughly in section 4.5.

3.1 Value Creation in the Power Market

The cash flow consists of two main variables which generate the income, price and volume. In addition, the cash flows also consist of expenditures, both variable and fixed. Roughly speaking, the cash flow can be formulated as:

$$\begin{aligned} & \text{Revenue} - \text{Costs}(\text{tax and depreciations included}) + \text{Depreciations} \\ & \pm \Delta \text{Net working capital} - \text{Capital Expenditures} \end{aligned}$$

The revenue is a function of price and volume of ordinary sales of electricity, plus sales of green certificates, which consist of the price of green certificates and volume of electricity sold. Depreciations will be thoroughly assessed in section 4.2.1 and the net working capital is irrelevant for this project, due to the sophisticated process of income and expenditures explained in section 4.3.

All power that Company X manufactures, are traded on the Nordic power exchange, Nord Pool, and the price is determined daily through bidding rounds on the exchange. Producers of electricity report how much they are willing to sell the electricity for, and the distributors report how much they are willing to pay for the amount of electricity needed the next day. Finally, prices meet at an acceptable level for both parties, referred to as the *system price*.



Figure 3: Supply and demand of electricity capture the system price in equilibrium

This implies that Company X is selling to the wholesale market, and not directly to private consumers. The higher the consumption of electricity, more cost intensive production methods need to be applied, which leads to higher electricity prices. The system price is determined by the interaction between supply and demand (Company X, 2017a), as illustrated in figure 3. A vital part of Company X's value creation is determined by the price set at the power exchange and the quantity of electricity sold. For this reason, Company X is dependent on establishing its project in an area with stable high wind conditions. Unfortunately, it is not possible to regulate- nor store wind accurately, as opposed to hydropower. Thus, it is needed to extract the energy at once and sell it, otherwise the energy will be lost (Fornýbar, 2017a).

Wind is considered a natural energy resource, thus it is free. Nonetheless, the investment required to capture this resource is initially huge. There are no production costs in producing electricity, which means that the marginal cost of producing one more unit (MW) of electricity is roughly zero. Balakrishnan et al. (2004) developed a framework to measure the opportunity cost of resources with different economic characteristics. They define in what degree a resource benefit is granular, fine or coarse, to determine how to measure the opportunity cost. Wind is characterized as a fine granularity-, low storability resource, with low control of consumption. In other words, wind is portrayed as a "use-it-or-lose-it" resource (Balakrishnan et. al. 2004). Hence, the opportunity cost

of extracting the energy is zero, which leads Company X to produce electricity even though the prices are low (Fornybar, 2017a).

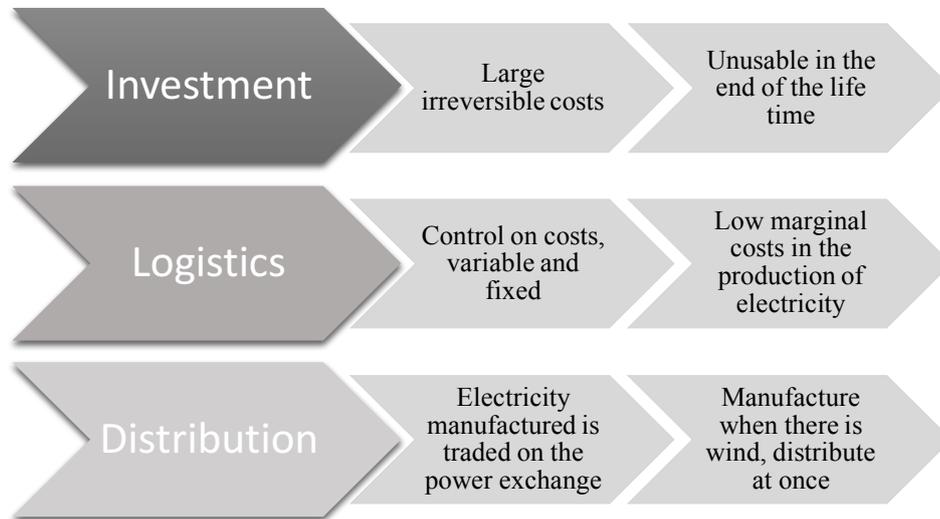


Figure 4: Excerpt of Company X's value chain

Figure 4 illustrates the value chain of Company X in a roughly manner. The specific investment in the wind turbines, logistics and distribution are considered to be key areas in generating a positive cash flow.

A negative side of this investment is that the wind turbines cannot be reused at the end of its life time. This hinder the opportunity of gaining a residual value by selling the construction. Yet, the construction can be sold for parts at virtually the same amount as dismantling the construction, leading to the conclusion that Company X neither- loses nor gains money at the end of the project's lifetime.

The logistics captures how Company X allocate costs during the project life time. Predictability and stability define such a project with its high amount of fixed costs and low marginal costs. There are some small uncertainties regarding marginal losses and regulatory costs, but this will be carefully explained under section 4.2. The distribution and production of electricity is fairly discussed in section 3.1.

Since the market sets the price of electricity, a natural focus will be on the production volume. This is determined by the amount of wind flowing through the area and

downtime in the production. Both these variables are hard to predict, which requires Company X to possess professional competence on maintenance and accurate wind measuring equipment to keep production flowing. In general, the wind farms are located at strategic locations along the coast or at desolate heights, in order to capture as much wind as possible.

3.2 The Power Market

Managers often define competition too narrowly, as if the competition occurred among today's direct competitors. In order to understand industry competition and profitability, one must analyze the underlying structure of the industry.

Michael Porter splits this structure into five different forces: threat of new entrants, rivalry, threat of substitutes, and bargaining power of- suppliers and customers. If the forces are intense, almost no company earns attractive return on investments. If the forces are weak, it increases the possibility of making abnormal returns (Porter, 2008).

The power market is structured as follows (Fornybar, 2017a):

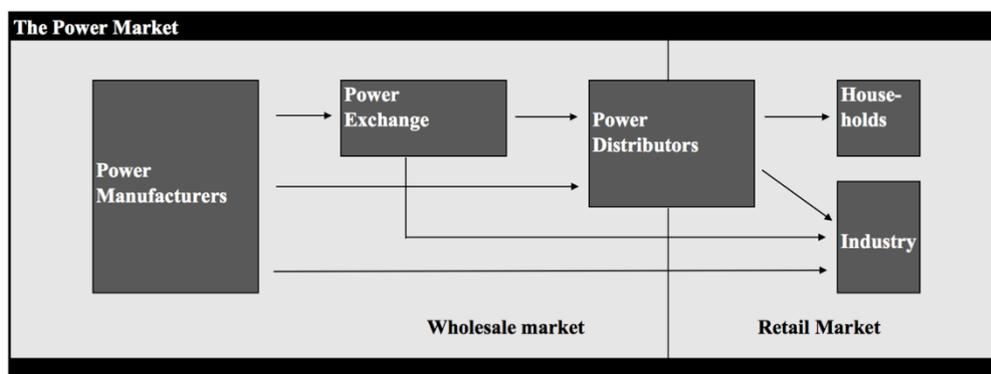


Table 2: Illustration of how the power market distributes power from the manufactures to the receiving households and industries

Company X's production of electricity is traded at the power exchange, which is bought by other businesses that distributes the electricity to the retail market. If demand is high and supply is low, consequently, the prices will be high.

The Transmission system operator (TSO) is responsible for keeping the respective area electrically stable. In other words, the TSO is responsible for the power arriving to the end user. The TSO must be a non-commercial organization that is neutral and

independent with regards to stakeholders in the market. In the wholesale market, the electricity is bought and sold hourly under the name, *hour of operation*. In the case of excess electricity, the TSO must pay the distributor for the remaining gap between their customers' purchase- and consumption. Electricity traded back to the TSO is referred to as the *balancing power*, often called the regulating power, which is exported abroad (Nordpoolspot, n.d).

The wind power industry is very capital intensive and requires high initial expenditures, which is irreversible. This makes the entry- and exit barriers high, and lowers the threat of new entrants. On the other hand, the project manager of Company X points out that foreign investors prefer to allocate their capital into renewable energy projects, rather than keeping it in the bank. A wind farm project is projected to be of low risk/low return, but is still better than losing money in the bank, due to inflation. Easier access to capital may increase the threat of new entrants, even though it can just as well be a positive factor regarding future funding of larger cooperative wind farm projects (Project manager, 2017).

Further, since Company X do not deliver electricity to the retail market, the customers bargaining power do not affect them. Thus, the users are able to switch power suppliers, and the distributors can buy electricity on the open market. Company X may however be affected by the suppliers bargaining power in a way that they need to invest and install wind turbines. It exists only a handful of wind turbine suppliers, which indicates that Company X may pay more than they otherwise would. The specific project to be analyzed, consists of only five wind turbines which is a relatively small amount, and in turn decreases Company X's bargaining power toward their suppliers.

The threat of substitutes to electricity is non-existent, as there are no good substitutes to electricity. However, there exist many substitute ways in how electricity is manufactured. Wind power can be categorized as a small portion of the total electricity production and there are far greater threats to consider before worrying about substitute electricity sources. However, in recent years there has been an increasing focus on wind power as opposed to other electricity sources, and consequently this thesis considers the threat of substitutes equivalent as non-existent (Hope, 2011).

There seem to be a slight rivalry in this industry when it comes to the possibility in capturing strategically windy areas and building-cost efficiency. However, since there exist only a few suppliers of wind turbines, and the costs of building the parks are quite high, the initial investment is critical. The crucial factors will be to extract as much electricity as possible at the highest volume, in addition to structuring the fixed costs correctly. In that way, the project will have a greater probability to generate positive cash flows, which are aligned with the true value creation over time.

Furthermore, Company X are obligated to apply for concession before considering if a project is worth investing in or not. This concession gives an actor the right to initiate production of wind power within the next 5 years, in a specific area for a 25-year production period. It is the government's responsibility to assess the application for concession, and there are no reports of discrimination between companies at this point in time. However, one particular note in the concession rights concerns the landowners, which actually control the land whom Company X and other competitors want to start wind production. The project manager reports that in some cases, landowners have declined a better monetary offer and chosen a local, national company. This taken into consideration might give Company X an advantage over foreign competition trying to get a stake of the Norwegian wind market (Project manager, 2017).

The PESTEL framework analyzes the external factors or surroundings, which may affect the business or the project. The first factor is the *political* implications. In the aftermath of the deregulation of the power system in 1991, the Nordic power exchange was established, and functions as the market place for the trading of power. A governmental owned power distributor (Statnett) was given the executive responsibility of keeping the balance between supply and demand at any time. Statnett functions as the power market's TSO, such that one does not produce more electricity than what is required.

Statnett, which is responsible for the maintenance of the power grid, demand that manufacturers report their expected production one day a head. This can create a problem for wind power producers due to the unpredictability of wind. On average, they report their expected production a few hours in advanced, with the possibility of adjusting their production plan upon 45 minutes before the time limit (Fornybar, 2017a).

The term *deregulation* means that the government is no longer controlling the power market, and instead, free trade is introduced. This was done to create a more efficient market, with exchange of power between regions and increased security of supply (Nordpoolspot, 2017b). As a result of a dynamic market, the power can be bought or sold across areas and countries more easily.

Today, there is an agreement among politicians and stakeholders in the Nordic power markets that the method discussed above, serves the society well. While the system price is determined according to supply and demand, the method reveals where issues may arise in the power grid. Typically, from changes in the price. This makes it easier to identify where the production capacity is constrained and differences between supply and demand. (Nordpoolspot, 2017b). The conclusion drawn from this, is that the political deregulation of the power market had a positive effect on the market.

In 2008, a collaboration between England and Norway was initiated, with the purpose of linking the two countries with a power cable. This partnership is between Statnett and the British National Grid, and the cable compound is referred to as the North Sea Link. When there is much wind in Great Britain and the wind power production is high, Norway can purchase cheap electricity from England and save the water power production. The whole point is to ensure that this operation go both ways between the two countries. The cable is intended to be ready for use in 2021, and the transaction of renewable energy is supposed to contribute with (Statnett, 2013):

- Increased certainty regarding supply, such that Norway may import cheaper electricity if the production is low.
- Increased value creation, because Norway may dispose of unused energy.
- More predictable supply and prices throughout the year.

Another external factor that may affect the industry, in which Company X operates in, is the *technological* implications. Wind power production is still in an early phase in developing ways of extract energy efficiently. Important activities within research and development contains improvements on large wind power constructions, suitable for harsh conditions both on land and at sea. The focus is set on optimizing- both design and predictability tools to measure wind. Also, one can harvest more energy from an area,

seeing as there are differences of the power production at good- and bad locations (Fornbybar, 2017c). Usually, windy areas often exist in very harsh environments, as the sea for instance.

Wind is a fluctuating energy source, which can be alleviated by diversification of wind farms. Over time, more wind farms are established, and the reliability of wind power as an energy source will increase (Fornbybar, 2017c).

Reduction of emissions is a vital target for most countries' *environmental* policy. This target is the reason for subsidiary efforts made by the government in energy efficiency and renewable energy production. When discussing the framework of renewable energy, the topics focus most often on measures taken by the government to increase the competitiveness of this industry. Renewable energy often requires substantial capital expenditures and low operating expenses. However, the ones investing in renewable energy compete first and foremost with those who provide energy based on fossil fuels. These competitors often have low initial costs which gives them a short-term advantage toward those within renewable energy (Fornbybar, 2017b).

In January 2012, Norway and Sweden established a market based on subsidiary effort, named the electricity certificate scheme (Energinorge, 2017). This is based on the Swedish certificate market, which has existed since 2003 (Publikasjoner.nve, 2014). Electricity certificates, commonly known as *green certificates*, are subsidies to power companies that produce renewable power.

In order to receive these subsidies, companies need to *bill* their distributors, which are enforced by the government (Hovland, 2017). The purpose of this initiative is to encourage the industry to increase investments towards wind power. Thereby, reducing pollution and diversify power production, such that it displaces the consumption of fossil energy (Hagem and Rosendahl, 2011).

This scheme was set in motion to ensure that the two countries could reach their main target on the environmental policy, to reduce emissions. Renewable production plants like water- and wind parks, with initiation during the period 2012 to 2021, are assigned one electricity certificate per MWh electricity they produce. By selling these, the manufacturers get revenues in addition to the normal power sales, which contributes to the profitability of producing renewable energy. The power distributors are obligated to

purchase one certificate per MWh of manufactured power they are buying. However, these subsidies cease to exist at the end of 2021. Companies that invest in renewable energy after this point, will not be able to obtain these certificates and sell them to distributors. By initiate the project before 2021 one has the right to sell certificates the next 15 years (Energinorge, 2017). This will not entail any major consequences for the project to be analyzed, as it is initiated in the beginning of 2015.

Company X is striving to further improve their competitive position, through efficient production and finding new and cheaper ways of producing power. The *economic* gains from the operations are affected by prices determined in the market and regulations sat by the government. The combination of electricity prices and production are the most important uncertainty factors for the company. To be able to reduce some of the risk following from this, Company X uses derivatives in order to hedge their operations (Company X, 2016).

3.3 Opportunities and Threats

In the previous section, we pointed out competitive- and external factors that may affect the market in which Company X operates. However, from this many opportunities and threats arise.

In a report presented by Statnett in 2013, *socioeconomically utility by spot trade*, they state that the cable project will generate benefits both to the producers and consumers. Which one of the two who benefit the most, will depend on the price development. They state that in a year with low prices, the producers will benefit from the cable, which imply that they will sell their power to England at higher prices. However, when prices are high, the consumers will be beneficial from having the cables (Statnett, 2013). Whether this is beneficial for Company X is difficult to say, because it will depend on the price development.

According to Teknisk Ukeblad (TU), the cable to England will remove the power surplus. By exporting to England, a large part of the Norwegian power supply will vanish from the Norwegian market, which in turn will increase the power prices in Norway (TU, 2014). If we are to believe the analysis of TU, then the project initiated by Statnett

seems to be very beneficial for Company X, and one can expect higher prices beyond 2021.

By investing in wind power, Company X competes with other actors both in hydropower and fossil fuels power. An investment in both hydropower and wind power is very expensive as opposed to fossil fuels. Investing in power generated from fossil fuels has a much smaller initial investment, but larger operating expenses. This means that Company X has a disadvantage toward actors producing fossil fuel power, in regards to the capital expenditures. However, in Norway approximately 98 % of the power is manufactured from renewable energy sources, whereas only 2 % comes from fossil fuels (Olje- og energidepartementet, 2017). Consequently, threat from fossil power can be categorized as seemingly irrelevant.

Subsidies generated from sales of the electricity certificates, are contributing to the profitability in the production of renewable energy. How dependent are the projects of these certificates to be profitable? If this additional revenue is insignificant in making projects profitable, then this scheme is just a bonus. Further, if this is a crucial factor in taking on new projects, then this thesis regard this factor as a huge threat in the way that the certificates cease to exist 15 years after the project was initiated. However, this threat may be decreased, if the cable to England generates higher prices in Norway. If higher prices make up for the total loss of electricity certificates, is hard to say, but increased prices in the future will without question benefit Company X.

The location of the wind farms is very important to obtain- and produce energy. Often strategic locations for wind farms are in harsh environments, which highlight the importance of invest in new technology that could withstand such conditions. This will in turn bring more energy to produce power. Diversification may also be a key word, by increasing the geographical area of wind parks. It is the same logic as portfolio diversification in regard to capturing a steady flow of wind.

An opportunity that may help capture more energy is to structure the wind turbines such that one easier can implement new technology in existing construction. This may be, better tools to predict how much wind that will be available the next 24 hours, for instance. In addition to develop existent wind parks, an opportunity may be to delay the investment in a new wind park. This because, new development in wind turbines may

occur, which have better designs and lower capital expenditures. The capital expenditures constitute a large part of how profitable the project will be, and the option to delay and see if this occur, may make the project more profitable. Another reason to delay, can be to see if better tools to predict wind have been developed, which makes the estimate of how much one are able to produce more accurate. This technology has, however, been substantially improved the last decade, and today, the average production estimates per year is quite accurate.

4. Analysis

In this chapter, we will perform an analysis of the wind farm project based on theoretical foundation, and compare it to the assumptions made by Company X. The analysis will be divided into different sections, each with a discussion on similarities- and differences following each section.

4.1 Revenue

The cash flows are primarily what makes the project profitable, containing revenues, costs, depreciations and capital expenditures. In this section, the focus is set on the revenue function ($f(R_t)$) given by:

$$f(R_t) = P_t^{elspot} * V_t + P_t^{El\ certificates} * V_t^{El\ certificates}$$

where P_t^{Elspot} is the system price sat by the equilibrium between supply and demand, V_t is the amount of electricity sold each year. $P_t^{El\ certificates}$ is the price of green certificates and $V_t^{El\ certificates}$ is the number of green certificates sold.

The system price is determined by the amount of electricity needed. However, it is difficult to know how much electricity that is needed on a year to year basis, and since the price is determined by the volume, there exist a situation with two unknown variables. The electricity prices obtained from the Nordic power exchange (Nord Pool) are used as a foundation to simulate the future prices. Thus, it is possible to model an approximation of the revenue function using Monte Carlo simulation for future prices.

4.1.1 Simulating the System Price

The distribution of the electricity price changes is exhibited in figure 5. In the data section 2.1.1, we argued that the changes in electricity prices are close to normally distributed, which makes the estimation of the parameters needed easier when using a Monte Carlo simulation. This because, Monte Carlo simulations relies upon a repeated random sampling and statistical analyzes to compute the results (Damodaran, 2008, p. 214-216). The normal distribution is solely based upon two parameters, mean and

standard deviation. Jacob Bernoulli provided the muscle behind using probabilities with the discovery of the *law of large numbers*. He proved that a random sampling from a population has the same characteristics, on average, as the whole population. To illustrate this point, Bernoulli use coin flips, noting that the proportion of heads/tails approached 50 % as the number of coin tosses increased (Damodaran, 2008, p. 68-69).

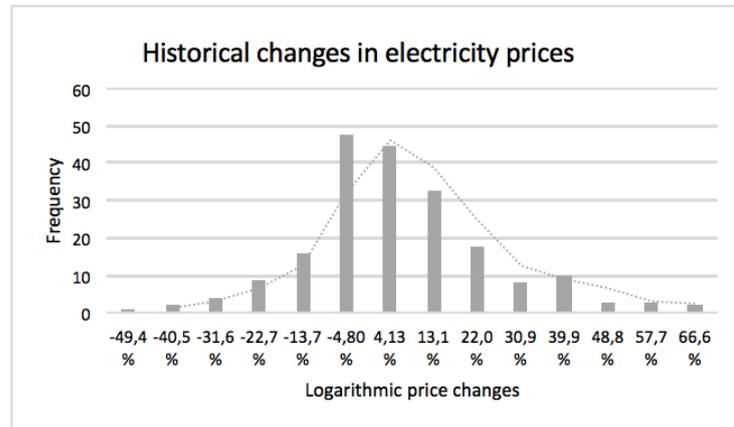


Figure 5: The distribution of logarithmic price changes

According to economic theory the price of any good is determined by matching demand with supply (McConnel and Brue (1998) referenced in Weron et al. 2004). Yet, electricity spot prices exhibit a behavior not observed in regular financial- or other commodity markets, as it does not only exhibit an independent identically distributed random walk process. This makes the model described in equation 8 in section 4.1.1.2 somewhat inappropriate. The most important factors which cause this strange behavior are mean reversion, seasonal fluctuations and infrequent price jumps within short time periods (Weron et al. 2004). As illustrated quite clearly in figure 6, the prices have varied a lot during the period 2000 to 2015.

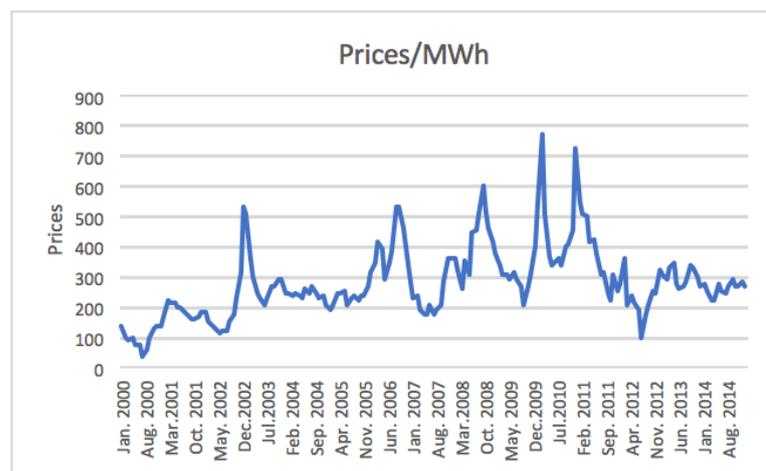


Figure 6: Monthly electricity prices/MWh over the last 15 years

The blue line in figure 6 indicates that the historical prices slightly mean revert through the period 2000-2015. Further, the prices have large infrequent jumps, and are to a large extent determined by seasonal fluctuations. If using this raw data in a Monte Carlo simulation, based on the model in equation 8, the future simulated prices will increase substantially, way beyond what is feasible. This happens when neglecting all other factors and merely consider the random walk component of electricity prices. The irregularity of electricity prices becomes severely overestimated in the long-term if not adjusting the short-term factors as price jumps and seasonal effects. The reason appears due to the high volatility which arise from the data sample graphed in figure 6. The historical volatility on an annual basis in the electricity prices is **65.8 %**, shown in table 1.

The annual seasonality is present in electricity spot prices due to changing weather conditions throughout the year. In most markets, it is dominated by a more irregular cyclic component dependent on macroeconomic variables (fuel prices and economic growth) and long-term weather trends. In time series literature, this is referred to as a trend-cycle component, however, in electricity price modeling this would be called a trend-seasonal or seasonal component. This to reflect the underlying annual seasonality (Weron and Zator, 2014).

In an extensive research on forecasting the long-term seasonal component (LTSC), Nowotarski et al. (2013) referenced in Weron and Zator, (2014), considered over 300 models. They found that the wavelet-based models, non-parametric smoothing technique, was better at extracting the LTSC from a series of spot electricity prices, and significantly better at estimating these. A clear disadvantage of using this model, is the severe complexity and the lack of ready-to-use codes for computing the model. To facilitate this problem, Weron and Zator, (2014) suggest the use of a much simpler, yet equally powerful method for identifying the LTSC in electricity spot price series, namely the Hodrick-Prescott (HP) filter. The HP-filter is a widely-recognized tool in macroeconomics. Although the filter was initially designed for a different purpose, it proves to work quite well in the context of electricity markets. The mechanics of the filter divide the series into two parts, a smooth and a volatile one. In the context of electricity markets, the smooth part may be interpreted as the long-term (trend)-seasonal component, and the volatile part as the stochastic component. The filter is a non-

parametric method, which returns a smoothed series g_t for a volatile input series y_t (Weron and Zator, 2014).

Applying the filter with the purpose to de-trend the price data, the trend component g_t will be determined by:

$$\min \sum_{t=1}^T (y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2$$

In this minimization problem, the number of observations and λ (lambda) are parameters determining how smooth the estimated trend will become (λ = smoothing parameter). If $\lambda = 0$, the solution to the problem is that all changes in y_t are caused by changes in the trend. If $\lambda \rightarrow \infty$, the change in the estimated trend will be constant. Both these cases are unrealistic, and a reasonable value will consequently be $0 < \lambda < \infty$. Determining the accurate value of lambda in practice is difficult, resulting in many papers regarding this issue. There is a general agreement when working with quarterly data that, $\lambda = 1600$ is a good fit. On the other hand, there is less agreement regarding the parameter when working with yearly and monthly frequencies (Ravn and Uhlig, 2002). However, in the literature it has been established a standard indicating that: If working with yearly data, $\lambda = 100$, for quarterly data, $\lambda = 1600$, and for monthly data, $\lambda = 14400$ (Grytten and Hunnes, 2016, p. 60-61).

The observations in the sample are of monthly frequency, which leads us toward using a $\lambda = 14400$ in the filter. However, the determination of λ is somewhat subjective (Mise et al. 2005), meaning that a value for one sample, does not have to fit with another. This is the case for this sample, as $\lambda = 14400$ smoothens the trend too much. In order to estimate the future volatility, the purpose is to remove extreme values, but the smoothing cannot be too excessive. Often the users of the filter use a *trial- and error-* approach to make the best fit. This thesis finds that using $\lambda = 2500$, provides a good fit for the purpose of removing the extreme values, while keeping a realistic volatile pattern that characterizes the electricity market.

The HP-filter is run through the historical electricity prices, such that the seasonal component and the infrequent price jumps are removed from the data. Consequently, the volatility of the filtered sample will decrease substantially compared with the original volatility of the electricity price data. This is illustrated in figure 7 where the orange line

exhibits the filtered sample and the blue line reflects the historical prices. We observe from the orange line that the greatest price spikes (illustrated by the blue line) are no longer part of the sample. This approach removes the erratic behavior of electricity prices and affects the simulations of future prices, such that they will become more trustworthy.

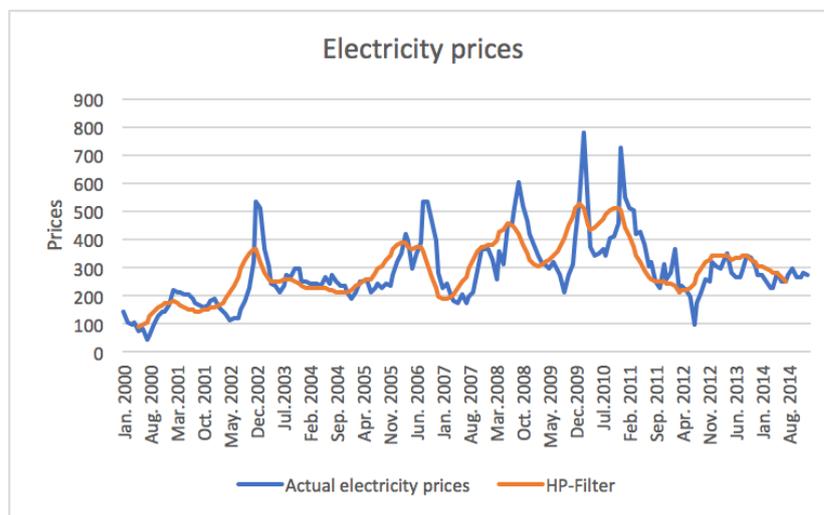


Figure 7: Monthly electricity prices/MWh with Hodrick-Prescott filter over last 15 years

Figure 7 illustrates that the filter stops before the actual historical prices. One of the weaknesses using the HP-filter is that endpoint issues often arises. When the filter estimates a trend, it uses observations both forward ($t+1$) and backwards ($t-1$), in which the sample does not have any observations. This causes the endpoints to be affected by actual values, leading to auto correlated extreme values, either upwards or downwards. This issue can be managed by reducing the sample in which the HP-filter is applied, as illustrated in figure 7 and will in turn further decrease the volatility of the filtered sample (Mise et al. 2005).

The HP-filter follows the path of the historical prices, but rejects the extreme values which have occurred throughout the period. Thus, the original price series is decomposed and reconstructed into an approximation series. The filter does not impose any regular structure on the smoothed series allowing for a better fit of the original signal, it only penalizes for roughness of the smoothed series (Weron and Zator, 2014). Consequently, the volatility becomes more manageable when using it as an input in the simulation.

A simulation is only as good as the probability distribution for the inputs that are fed into it (Damodaran, 2008, p. 214-216). The normal distribution requires the standard deviation, but since the purpose is to estimate future electricity prices, one may try to forecast the volatility and use this instead of the historical standard deviation. Hence, an AR (1) process and GARCH error components are applied to predict the future values of the approximation series.

4.1.1.1 Volatility Forecasting, GARCH (1.1)

The generalized autoregressive conditional heteroscedasticity (GARCH) model yields what is believed to be the assets volatility at time $t+1$. The model considers the moments of a time series as variant, which means that the real value minus forecasted value does not have zero mean and constant variance. The GARCH model aims to predict future variance σ_{t+1}^2 , by using past squared observations and past variances. The GARCH (1.1) model is estimated by the following model:

$$\sigma_{t+1}^2 = \alpha_0 + \alpha_1 \sigma_t^2 + \alpha_2 r_t^2 \quad (5)$$

Where α_0 , α_1 and α_2 are parameters to be estimated using maximum likelihood to yield consistent estimates of the model parameters and corresponding estimates of the conditional variances (Harris et al. 2007). With an assumption about the conditional distribution of price changes, maximum likelihood estimates of the model parameters can be obtained using an iterative optimization procedure (Guermat and Harris, 2002). The function of the maximum likelihood estimation is given by equation 6.

$$\ln L(\alpha_0, \alpha_1, \alpha_2) = -\ln \frac{\pi}{2} - \frac{1}{2} \ln \sigma_t^2 - \frac{1}{2} \frac{r_t^2}{\sigma_t^2} \quad (6)$$

By estimating the volatility based on equation 5 and 6, we obtain volatility estimates which are illustrated in figure 8.

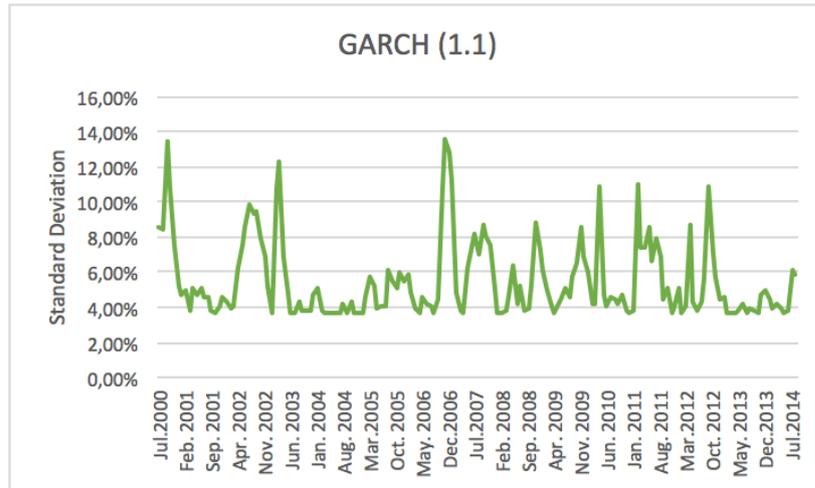


Figure 8: Forecasted monthly volatility on filtered electricity prices using GARCH (1.1)

These forecasts originate from the price trend determined by the HP-filter, illustrated in figure 7. The estimated volatilities in figure 8 capture the variations from the historical prices quite accurate, which substantiates the fact that GARCH is a good approximation to future variations in electricity prices. The previous period's weighted price change and volatility determine the next period's volatility. The weights obtained through the maximum likelihood and the average monthly- and annual volatility are displayed in table 3.

GARCH	
a0	0,001333817
a1	0,000010544
a2	0,606622199
Sum	0,607966560
Monthly Std dev	5,5 %
Annualized std dev	19,0 %

Table 3: GARCH parameters, where $\alpha_0, \alpha_1, \alpha_2$ are the estimated weights following from the maximum likelihood iteration

The average monthly volatility obtained from GARCH is **5.5 %**. In order to convert this into annual volatility, which is needed in the simulation, we have the following equation:

$$\sigma_{annual} = \sigma_{monthly} * \sqrt{12} \quad (7)$$

The annual estimated volatility from using GARCH is **19.0 %**, which is substantially lower than the historical volatility before adjusting the sample for extreme price fluctuations through the HP-filter (**65.8 %**). By additionally computing annual historical volatility of the trend, we obtain a standard deviation of **20.8 %**.

The volatility input used to simulate future electricity prices will be from the GARCH-method, as historical volatility may include information that are not relevant to the future. Therefore, by using GARCH, we estimate a future volatility conditional of last period's volatility which is more representative to the future. The GARCH process provides a more authentic context, rather than using historical volatility to predict future prices. However, it would not make that much difference if we were to use the historical volatility measured from the price trend. The volatility estimate is approximately 20 %.

4.1.1.2 Monte Carlo Simulation

The future values of the approximated price series are predicted by a Monte Carlo simulation, which simulates hypothetical changes in prices created from random draws by a stochastic process (AR(1) process). This is otherwise known as the Geometric Brownian Motion, denoted by epsilon (ε). A random standardized normal variable, together with the standard deviation drive the future electricity prices by simulating the price each year a *thousand times* (Dowd, 1998, p. 114-115).

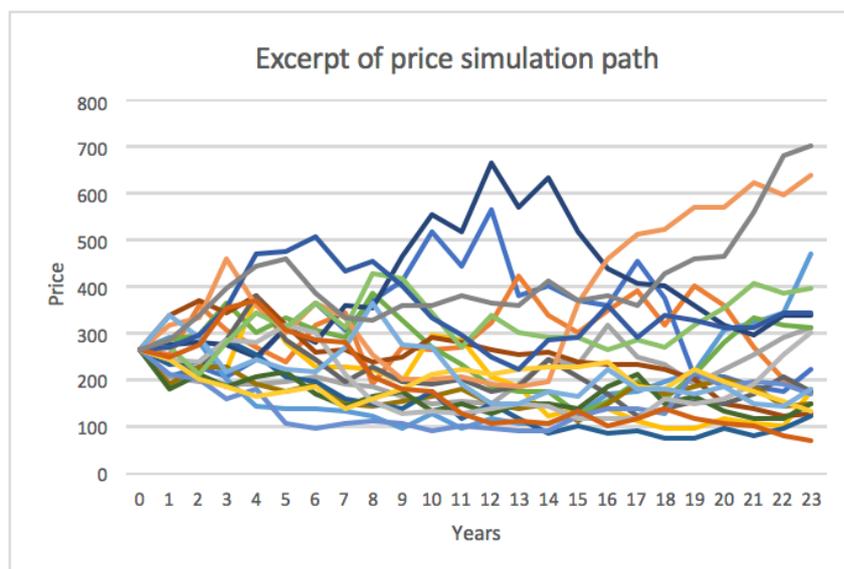


Figure 9: An excerpt of the price path from 1000 simulations

Equation 8, exhibits that tomorrow's log price is a function of today's log price, plus the standard deviation multiplied by the random number distribution variable, epsilon. The price used as the input is the last year average observed electricity price in the sample, equal to **263.20 NOK/MWh**.

$$\ln P_{t+1} = \ln P_t + \varepsilon \sigma_t \quad (8)$$

Equation 8 takes the form of a first-order autoregressive model (AR(1)) with the special case of random walk, given by:

$$y_t = \rho y_{t-1} + v_t$$

where variable y_t depends on its lagged variable and $\rho = 1$. The model shows that each realization of the random variable y_t contains last period's value y_{t-1} plus an error v_t . These time series are called random walks because they appear to wander slowly upward or downward with no real pattern. The random walk model contains an initial value plus a component that is the sum of the stochastic terms $\sum_{s=1}^t v_s$. This latter component is called the stochastic trend. If the variable y_t is subjected to a sequence of positive shocks, $v_t > 0$, followed by a sequence of negative shocks, $v_t < 0$, it will have the appearance of wandering upward, then downward (Hill et al. 2012, p. 480-481).

The random walk has a mean equal to its initial value and a variance that increases over time, eventually becoming infinite. However, although the mean is constant, the increasing variance implies that the series may not return to its mean (Hill et al. 2012, p. 481).

The simulations of future electricity prices were computed to match the development of the prices the next 23 years. Figure 9 illustrates an excerpt of the price simulation paths of the future electricity prices, and table 4 contains the future average electricity prices of 1000 simulations each year. On average, the electricity prices will smoothly increase over time, as a result of equation 8 on which the simulations are based (Benninga, 2014, p. 692).

Prices		
Year	Simulated Prices/MWh:	Price change in %
2016	267,94	
2017	271,55	1,35 %
2018	277,04	2,02 %
2019	283,46	2,32 %
2020	291,31	2,77 %
2021	298,37	2,42 %
2022	302,30	1,32 %
2023	309,13	2,26 %
2024	316,13	2,26 %
2025	321,91	1,83 %
2026	327,66	1,79 %
2027	331,97	1,32 %
2028	336,70	1,42 %
2029	342,46	1,71 %
2030	345,81	0,98 %
2031	359,75	4,03 %
2032	366,22	1,80 %
2033	371,52	1,45 %
2034	384,88	3,59 %
2035	396,02	2,90 %
2036	405,65	2,43 %
2037	419,73	3,47 %
2038	424,82	1,21 %

Table 4: Exhibits the estimated future annual prices/MWh and the respective price changes. The project period is expected to last for 23 years (until 2038)

The forecasted prices display a smooth price-increase, even though figure 9 exhibits significantly varying price paths in the underlying projections. The explanation following from this is the increasing variance from the random walk and average estimates of the prices given by the simulation. To illustrate the price variations within one year, figure 10 illustrates 200 simulations in year 2020.

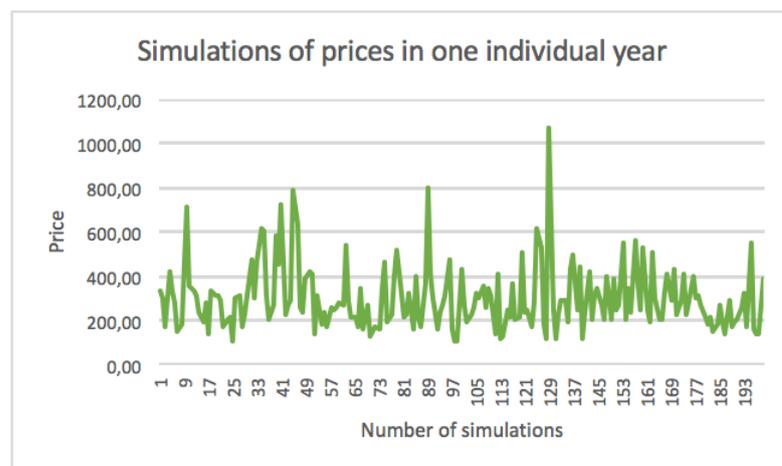


Figure 10: Illustrates 200 simulations within year 2020

Even though this price estimation is carefully implemented, there is still uncertainty attached to whether it actually is feasible. As mentioned in the strategic analysis the price is set in the equilibrium between supply and demand of power. It all depends on how much electricity is needed and how much is produced during the year. Even if Company X can predict an estimate of how much they are going to sell during a year, the price will continue to vary due to the sales of other producers. Hence, the prices are not affected by competitive advantages in the power market. Moreover, Company X cannot store the wind energy and must therefore sell what they produce regardless of price. Nonetheless, these future prices are determined by a forecasted volatility based on previous variations in price, adjusted through filtering and a random walk process. This leads us to believe that the prices will function as an approximation to actual future prices. In the strategic analysis, the thesis points to the possibility that the electricity prices will increase after 2021. In addition, the simulation illustrates that the prices in fact may increase with approximately 54 NOK/MWh between 2020 and 2030. This strengthens our beliefs that the probability of an increase in the average electricity price during the project lifetime is realistic.

4.1.2 Simulation of Green Certificate Prices

As with the electricity prices, we can obtain historical green certificate prices and use these as a foundation to estimate future prices using a Monte Carlo simulation.

The historical green certificate prices are obtained from Norwegian Energy Certificate System (NECS) on 6. March 2017, (Necs.statnett, 2017). The historically monthly prices range from July 2003 to January 2015. Figure 11 illustrates that the monthly historical prices, for the most part, have been between 140 NOK/MWh and 250 NOK/MWh, excluded the time-period 2008-2010.

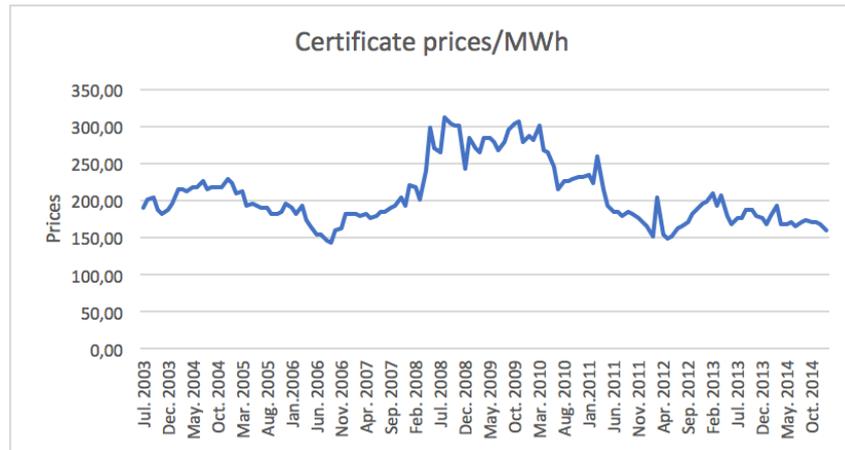


Figure 11: Monthly green certificate prices/MWh over the last 15 years

As opposed to the electricity prices, the historical certificate prices are not adjusted for extreme values using HP-filter. This is because the actual certificate prices do not display similar extreme values within short time-periods. The process of forecasting the volatility is illustrated in equation 5 and 6 above. Figure 12 illustrates the estimates of volatility using GARCH. By comparing figure 8 against figure 12, one observes that the volatility of electricity prices is on average less than the volatility forecasted from green certificate prices. Historically, the electricity prices have varied a lot more than the prices from certificates, but due to the filtering of electricity prices we removed the extreme values and thereby obtained a lower volatility.

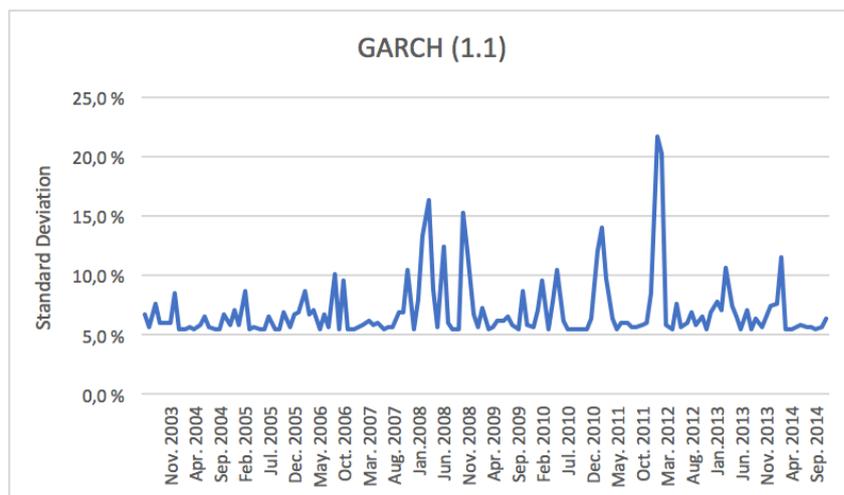


Figure 12: Forecasted monthly volatility on green certificate prices using GARCH (1.1)

Further, the thesis run a Monte Carlo simulation on the certificate prices, using a random number generation, with a forecasted volatility of **24.1 %**, and the last year average observed certificate price, **171.03 NOK/MWh**, as inputs.

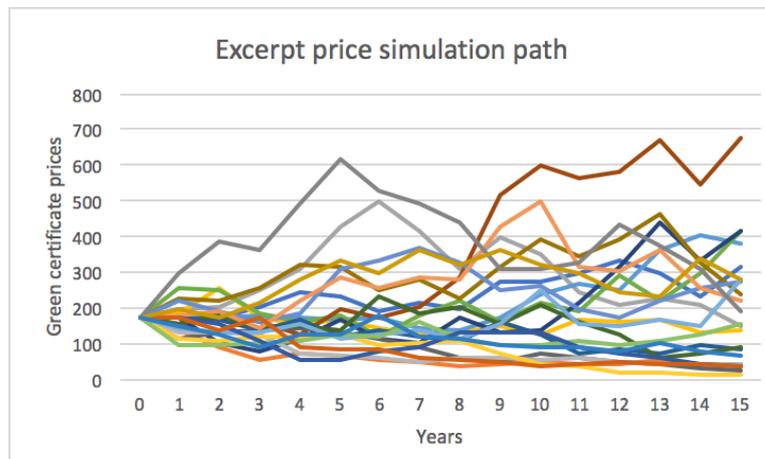


Figure 13: An excerpt of the green certificate price path from 1000 simulations

This simulation also follows the process illustrated in equation 8, which implies that the average certificate price of 1000 simulations each year will increase smoothly the next 15 years. Figure 13 illustrates an excerpt of the price simulation paths and the forecasted prices of green certificates are exhibited in table 5. From table 5, we observe that the green certificate prices increase more on average than the regular electricity prices.

Prices		
Year	Simulated Prices/MWh:	Price change in %
2016	173,33	
2017	177,22	2,25 %
2018	184,95	4,36 %
2019	191,02	3,28 %
2020	198,04	3,67 %
2021	201,64	1,82 %
2022	210,59	4,44 %
2023	218,61	3,81 %
2024	224,25	2,58 %
2025	231,01	3,01 %
2026	236,85	2,53 %
2027	247,16	4,35 %
2028	255,08	3,21 %
2029	266,93	4,64 %
2030	278,39	4,29 %

Table 5: Exhibits the estimated future annual green certificate prices/MWh and the respective price changes. Company X has the right to receive certificates until 2030

Table 6 contains the summary statistics from the green certificate prices. The kurtosis is **3.510**, which is larger than the kurtosis of electricity prices. This can be interpreted as there is a higher possibility of extreme events in the green certificate price data.

Summary statistics el certificates		
	Monthly	Annual
Mean	-0,1 %	-1,48 %
Std dev	7,5 %	25,8 %
	LN % change	Price
Max	30,5 %	312,61
Min	-28,4 %	141,87
Median	0,1 %	192,64
	LN % change	
Skewness	0,207	
Excess Kurtosis	3,510	

Table 6: Summary statistics of monthly and annual green certificate prices

These future prices are also determined by a forecasted volatility based on previous variations in price and a random walk process. Leading us to believe that these prices also will function as an approximation to actual future prices of green certificates, even though the probability of extreme events is present.

The simulated prices both from electricity prices and green certificates will function as price data input in the analysis each year, as formulated by the revenue function $f(R_t)$.

Table 7 summarize the inputs used in the simulations, both for the electricity prices and the green certificate prices.

Inputs in simulation		
	Electricity price	Green certificate price
Price	263,20	171,03
Std dev.	19,0 %	24,1 %

Table 7: Prices and standard deviations used as input in the simulations. The notation behind the prices is NOK/MWh

4.1.3 Production Volume

Together with the price estimation, predicting the amount of produced power is vital to creating a realistic revenue function. There is some uncertainty related to this factor, but during the last 10 years, tools used to predict wind has become incredibly well-developed. The process of measuring wind at this specific location, started two years prior to the decision of initiating the project. Advanced technical procedures were used to measure the wind in the area to provide reliable estimates for future prediction (Project manager, 2017).

The access to wind per turbine is measured in average hours of production each year, which on this project were estimated between 2900- and 3300 hours per year. The project manager affirms that the company has a common practice of choosing a safe estimate, and thereby approximated a production average of 3000 hours yearly per turbine. One turbine has an effect of 3 MW and this specific project consists of five wind turbines, resulting in a yearly average production of **45000 MWh**. However, the project is initiated in March 2015, but the operation does not start until April 2016, due to the development of the wind farm. This means that the production of power the first year is 75 % of 45000 MWh. The project is shut down in the year-end 2038, which deliver 23 years of operations (Project manager, 2017).

4.1.4 Theory versus Practice on Revenue

The revenue function is given by:

$$f(R_t) = P_t^{elspot} * V_t + P_t^{El\ certificates} * V_t^{El\ certificates}$$

This is the theoretical approach to estimate future income, where P_t^{elspot} and $P_t^{El\ certificates}$ are the biggest uncertainty factors. Company X estimates their future income using the same type of revenue function. $V_t = V_t^{El\ certificates}$, as discussed in the strategic analysis, where Company X receives one electricity certificate per MWh of manufactured power registered in the market. The estimation of volume does not differ between the theoretical- and practical approach, since it is considered to be of industry

knowledge. In addition, theory does not state any better approximations to future production.

Consequently, the results from the revenue function will deviate from each other when it comes to the electricity price estimation. In terms of future price estimation, the thesis uses Monte Carlo simulations based on a filtered sample (HP-filter), GARCH(1.1) and a random walk process, explained from a special case in an autoregressive process of 1. order (AR(1)). In practice, Company X uses a THEMA-model, which is an optimizing model based on several variable inputs. Such inputs, could be coal prices, oil prices, water inflow (hydropower) etc. This model captures many variables affecting the equilibrium of supply and demand, and ultimately optimize the prices in a stochastic process. This model applies primarily for estimating the system price and is aligned with empirical studies (Project manager, 2017).

The green certificate prices are very difficult to predict. The hardship of these prices appears because the certificate market is regulated by the government, where the stated total demand of wind power is 26.4 TWh, both in Norway and Sweden (Project manager, 2017). According to the project manager, they developed their own model in predicting future green certificate prices, where projects are being ranked in a project portfolio to obtain marginal prices in relation to the demand at 26.4 TWh.

However, Company X's different departments cooperate well with each other, where the engineers provide the economists with highly reliable information needed to make good projections. Their approaches to estimate future prices are extensive and accurate, containing a lot of market data and inputs (Project manager, 2017). This lead us into believing that their estimates are a robust alternative to our theoretical approach.

Whether, Company X's model is more accurate than the theoretical framework applied above is difficult to say. To assess this, one must wait and see what the actual price appears to be in the future.

4.2 Costs

What really separates investing in wind farms from other investments are that yearly costs of maintaining the business cycle are less vital for the overall value creation. Figure 14 illustrates the portion of costs in the second year of operation, 2017. The figure divides the different costs which apply to the project into different portions. Note that only 29.03 % of the total costs are considered variable. Variable costs consist of regulatory costs, marginal loss rate, property tax, income tax and the lease of the power grid. 70.97 % of the total costs are considered fixed, where the largest portion is a result of the depreciations. The fixed costs, except the depreciations, are assumed to increase with the inflation. The future inflation rate is set at the same rate as Company X, which is aligned with the inflation target determined by the Norwegian Government at 2.5 %.

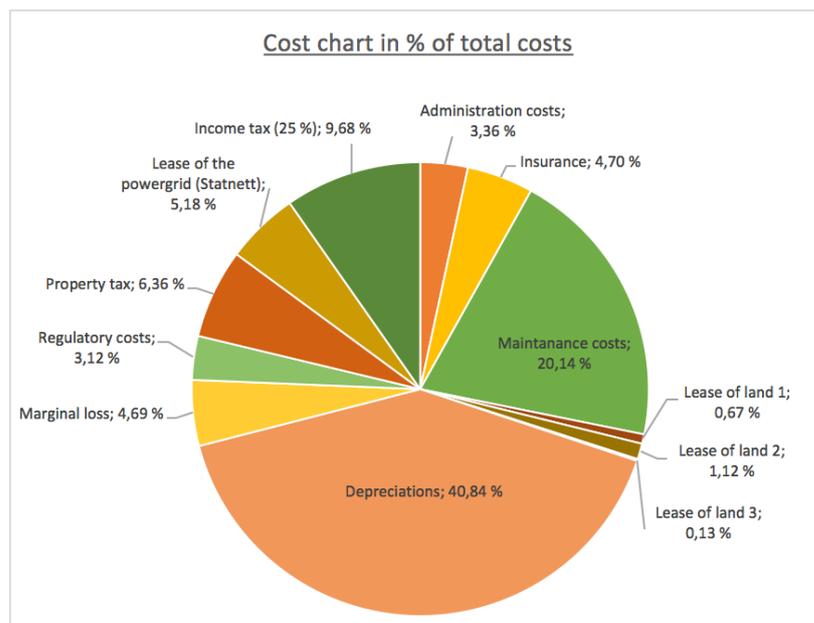


Figure 14: An illustration of different cost classes and their respective share of total costs for 2017

This wind farm investment results in a high up-front investment of 147 MNOK, which creates a huge amount of fixed irreversible costs. Beside from that there exist some industry specific costs worth explaining.

Company X is obligated to pay a share of 18 NOK/MWh produced, as a rent to operate the power grid owned by Statnett. This is a tariff, which is variable since MWh produced might vary from year to year. Another distinctive cost is *marginal losses* from producing

and transporting the electricity. The project manager estimates this loss to be 6 % of total production until 2019 and 3 % for the remaining lifetime of the project. This is substantiated by increased technology and growing experience. However, marginal losses follow a continuous improvement during the project's lifetime, and it is therefore appropriate to smoothen out the marginal loss rate. Instead of assuming a marginal loss rate of 6 % until 2019, and then 3 % for the remaining lifetime, we find it more accurate to apply a 6 % loss rate until 2022, 5 % until 2028, 4 % until 2033, and 3 % until the project ends.

The regulatory costs represent a negative impact in terms of predicting produced electricity. Company X must report to the market one day in advance how much electricity their wind farm will produce, and overestimating production volume will result in a payment of the remaining difference in volume. Measuring short-term production is quite difficult, but the long-term production through a year is very accurate, as illustrated in figure 13 only 3,12 % of total costs come from regulatory measures. Finally, the property tax is set by the government to be 0,7% of the development costs of the wind farm, each year to its book value.

Both the *marginal loss* and *the regulatory costs* can be formulated as a function of the revenue provided by the normal power sale, without the sale of green certificates given by: $g(x) = \theta * P_t^{elspot} * V_t$, where $g(x)$ represents the costs both of marginal losses and regulatory costs, θ represents the loss factor and V_t is the amount of electricity produced.

The Norwegian corporate tax is set at 27 % in 2015, but politicians were arguing that the corporate tax rate is going to decrease during the next couple of years. In order to approximate a more likely tax rate in the future, the thesis uses a tax rate of 25 % as the marginal tax during the projects lifetime. That being said, Company X applies a tax rate of 27 % as the marginal tax rate throughout the project (Project manager, 2017), which is the tax rate the firm faces on its last NOK of income (Damodaran, 2012, p. 250).

Depreciations are a measure of the depletion from the resources needed to perform the activities in a company. In other words, depreciations measure the costs arising from using the resources each year until all the benefits have been extracted from the resource. In this project, the resources are the rotor blades, tower, foundation, infrastructure and

generator. These resources are very expensive and require huge irreversible capital expenditures. The depreciations contain 40.84 % of total costs as a result of the high up-front investment.

Other standardized fixed costs are insurance, maintenance costs, administration and land lease. The latter constitutes a severely small portion of the total costs. The land lease is a fixed contract between Company X and the landowner, and gives Company X the rights to produce wind power in the specific area. This contract is non-revocable for both parties and lasts for the whole project period of 23 years (Project manager, 2017).

4.2.1 Two Perspectives on Depreciation Costs

The majority of costs associated with the wind farm project are taken as a given and the variable costs have been discussed extensively in the previous section. Nonetheless, it is worth discussing the different approaches used to obtain the depreciation charges.

For companies in Norway, the two most commonly used methods to calculate depreciations are linear depreciations (straight-line) and tax depreciations (accelerating). The Norwegian tax authorities demand that the depreciations must be calculated using the latter method (Heskestad, 2001, p. 28-29). In other words, there are no deviations in the way Company X measure the resource consumption and what the theory states. For internal purposes, however, there is a freedom of choice regarding which depreciation method to apply. The main purpose of depreciations is to correctly measure the costs of extracting the asset's benefits, and for this reason, we choose to deviate from Company X's tax depreciations. In the following we will argue for the different choices, even though the theory is aligned with the practical choice of the depreciation method.

Company X uses tax depreciations to illustrate the costs of using the wind farm's resources each year. The capital expenditures are depreciated using a percentage share of ingoing book value such that the depreciations decrease through time, given by:

$$D_t = \delta I_0 (1 - \delta)^{t-1}, \quad (9)$$

where δ is the constant depreciation rate ($\delta < 1$), determined by the tax authorities for the tangible asset. I_0 defines the total capital expenditures at the beginning of the project in

2015 (Heskestad, 2001, p. 28-29). By using this method, Company X will incur lower tax liabilities in the beginning of the project's lifetime. Company X sees this as an advantage, since the excess revenue from green certificates will cease to exist 15 years after the project is initiated. In other words, it is better to allocate a large portion of costs in the beginning of the project to even out the net operating profit less adjusted taxes (NOPLAT).

Despite these arguments, the thesis uses straight-line depreciations in the theoretical approach to the investment analysis. This is because the actual resource consumption is considered to be equal on a yearly basis throughout the project lifetime. The calculation of the straight-line depreciations follows the process:

$$D_t = \frac{1}{n}I_0, \quad (10)$$

where n represent the lifetime of the assets (Heskestad, 2001, p. 28). Tax depreciations are directly linked to cash outflows. Thereby, the depreciation rate determined by the government is the actual rate in which Company X is allowed to depreciate their assets. This makes the tax payments accurate, such that Company X will not incur any tax liabilities. Since the tax depreciations are directly linked to cash outflows, one can argue that using tax depreciations are the most accurate measure in order to obtain the cash flow.

That being said, the thesis finds that straight-line depreciations is a more appropriate measure illustrating the depletion of the assets, than having large depreciations at the beginning and then less depletion of the resources in the end. The intuition behind this is to better measure the actual value creation (NOPLAT) generated from the project, where it is assumed that an asset does not deteriorate that much in the beginning of its lifetime. Also, an asset would require more maintenance at the end of its lifetime, implying larger depletion of resources as the asset becomes older. Using this argument, perhaps the most proper depreciation method would be a progressive one, which increases the depreciations through time. In other words, the costs of having an asset increase as the asset becomes older.

Figure 15 illustrates the different depreciation methods throughout the project lifetime. The blue line illustrates much higher depreciation charges the first seven years (tax

depreciations). After 2022, the straight-line-method yields higher depreciations for the remaining lifetime of the project. In 2016, the linear depreciation cost is smaller than in the subsequent years, which follows from 3 quarters of operation in 2016, since the operations are initiated in April.

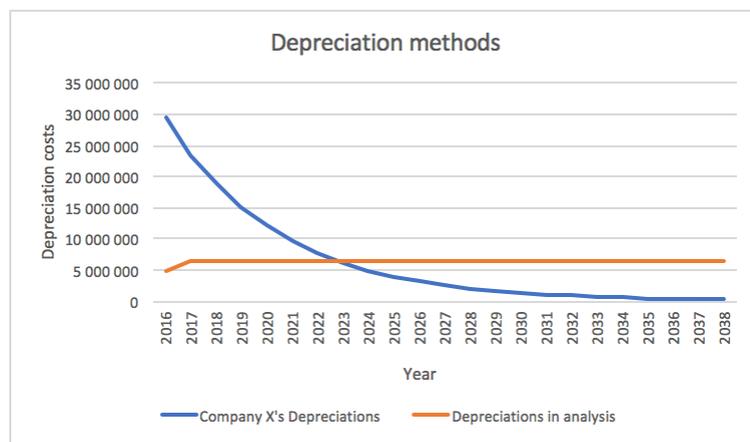


Figure 15: An illustration of the two different depreciation methods and the contrast in cost distribution

The conclusion drawn from this discussion is that the choice of depreciations made by Company X, is a reasonable choice. The tax depreciations lead to an accurate cash flow estimation. However, even though the tax depreciations are the accurate costs linked to the cash flows, the thesis still find that using straight-line depreciations tell a better story regarding the resource depletion, following from the arguments above. But we accept the choice of depreciations taken by Company X, and do not consider the different approaches as a deviation between theory and practice.

4.3 Working Capital

Working capital is usually defined as the difference between current assets and current liabilities. Increases in working capital tie up more cash and consequently contribute to more negative cash flows. Conversely, decreases in working capital release cash and generates more positive cash flows. Working capital varies widely across firms in different sectors and often across firms in the same sector (Damodaran, 2012, p. 264). Current assets tied to the operation are usually consisting of trade receivables and inventory, while current liabilities usually consist of trade, other payables and current tax liabilities. That being said, Company X has no noteworthy inventory as electricity

are sold immediately. Moreover, the settlement of selling the power is done before the hour of operation, and the cost of producing power is virtually non-existent, after the initial investment has been implemented. Hence, Company X does not need a lot of capital in the day-to-day operation.

With this in mind, working capital will not be considered in the analysis, since it will not provide a significant impact on the cash flows generated from the project. Company X neither calculates working capital into their analysis, which supports the argument above. This is also aligned with textbook standards that it should be calculated if there exist working capital needs, and if not, it should be omitted from the analysis. (Damodaran, 2012, p. 264-265).

4.4 Free Cash Flow to Firm

The cash flow captures the true income and outcome from the project over its lifetime and together with the cost of capital, they give rise to the net present value.

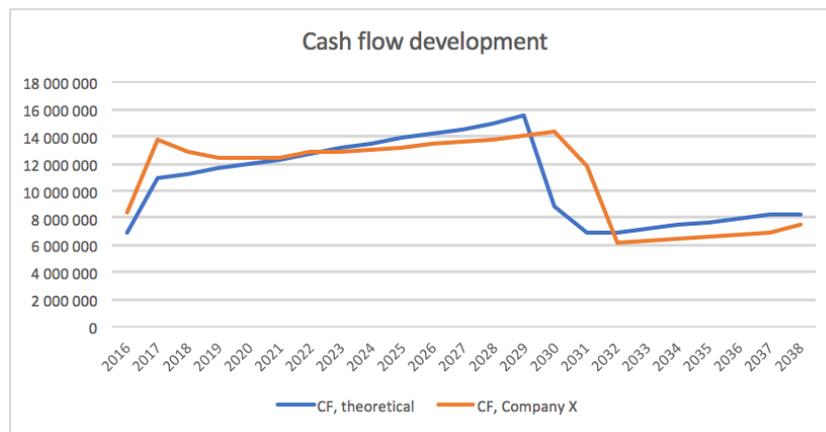


Figure 16: Exhibit of the development of the theoretical- and practical cash flow

By looking at figure 16, both the theoretical- and practical cash flow estimations are quite similar. The theoretical approach illustrates an approximately linear slope the first 15 years, while Company X's analysis starts at a higher level with downward sloping, before being linear after 2022. The difference between the two cash flow estimations in the first 8 years is due to the deviant depreciation characteristics. From that point on, a gradual increase in simulated electricity- and certificate prices creates a close to linear increase in the cash flow until 2030. Additional factors creating this linear slope is a large share of fixed costs and marginal cost being close to zero, as mentioned in the

strategic analysis in section 3.1. From an empirical point of view the simulated prices will probably differ in the future compared to the prices estimated by Company X. This is merely a result of high unpredictability towards future prices.

The dramatic cash flow downturn in 2030 is a natural cause of green certificates being liquidated after 15 years of production. As illustrated in figure 16, green certificates have a significantly huge impact on the total value creation of this project, and therefore considered to be a necessary factor to even consider investing in the first place. Interestingly the cash flow immediately restart the linear increase for the remaining life time and substantiates the fact that green certificates play a key role in the overall success of this project.

4.5 Cost of Capital

Theory behind the estimation of cost of capital was thoroughly explained in section 2.2, as a foundation for the calculations made in this section. The first model to be assessed is the CAPM, before implementing the WACC and obtain the project's cost of capital.

4.5.1 CAPM

A real project for a company not listed at the stock exchange, experiences problems underlying the CAPM assumptions.

First, The CAPM states that an asset covariate with the market, measured with the asset's beta. We do not have the opportunity to analyze historical stock prices and regress those against the market. Thus, finding a proxy that holds approximately the same characteristics as Company X is the only solution. However, there are no wind power companies listed on Oslo stock exchange, and thereby impossible to duplicate these characteristics perfectly. That being said, Hafslund ASA is listed, and will in turn function as a proxy for Company X, even though Hafslund only manufacture hydropower (Hafslund, 2017b). The arguments behind this choice lie within the fact that Company X also manufacture hydropower, indicating acceptable similarities. The overall firm risk may bear some resemblance to Company X. Even though the wind power project of Company X probably does not bear the exact same risk as hydropower projects.

To correct for the dissimilarities with Hafslund, we can de-lever the beta of Hafslund, and then re-lever it, using Company X's capital structure. What matters, is that the cost of equity we estimate using CAPM, reflects the systematic risk of the power market. However, risk is subjective, thus, we provide a theoretical approach to approximate the risk tolerance of Company X's owners in section 5.4.

The second problem revolves around the assumption that all investors are assumed to be well diversified, and not hold idiosyncratic risk. This will not fully account for this project, as Company X previously have invested in three wind parks, which reflect a degree diversification. That being said, these projects contain a great deal of idiosyncratic risk, due to the dependence of wind flow. A way to reduce this firm specific risk, is to invest in broad geographical areas as discussed in the strategic analysis. Moreover, CAPM states that there exist no transaction costs or taxes, and that every investor has identical information. To make an estimate of expected future return on the equity, we have to accept that we do not have perfect information, and thus, adjust what can be adjusted.

The data sets used in the following section are obtained from Yahoo! Finance 9. March 2017, and the historical stock/index monthly returns range from the beginning of January 2000 to the beginning of January 2015. The different data sets are the historical prices on the S&P 500 index, OSEBX and the Hafslund stock.

4.5.1.1 Beta

By using the monthly returns of Hafslund and the S&P 500 index the thesis estimates the parameters of the regression model $y_t = \alpha_0 + \beta_1 X_t + e_t$, using ordinary least squares. The least squares estimates are numbers that may, or may not be close to the *true* parameter values. Rather than asking about the quality of the parameters, we will examine whether the estimates are statistical significant through a *t-test* (Hill et al. 2012, p. 56-57). The variable y_t reflect the historical returns of Hafslund and X_t reflect the returns of the market (S&P 500). β_1 is the exposure of Hafslund stock against the market, in other words, the stock's beta. e_t represents the error term.

Before running the regression, we must correct for currency differences between the data obtained for Hafslund (NOK) and the data obtained for S&P 500 (USD). This must be done to ensure data consistency. The reason behind regressing the returns of Hafslund

against the S&P 500 is that S&P 500 represents a comprehensive index and define the market to a large extent.

By running the regression over the entire period, we obtain estimates on the parameters in the regression model. β_1 is the beta raw of the stock and has an exposure against the market of **0.862**. Indicating that the stock of Hafslund reacts less to changes than the market. If the market increases with \$1, the return from the stock is \$0.862. The regression shows that this parameter is highly significant, within a confidence level of 95 %. The R^2 of the CAPM regression is 18 %, which is the statistical fit of the model, but in finance literature it illustrates the systematic portion of the risk in the Hafslund stock. It follows that $(1-R^2)$ is the idiosyncratic risk of the stock (Böhren, 1997).

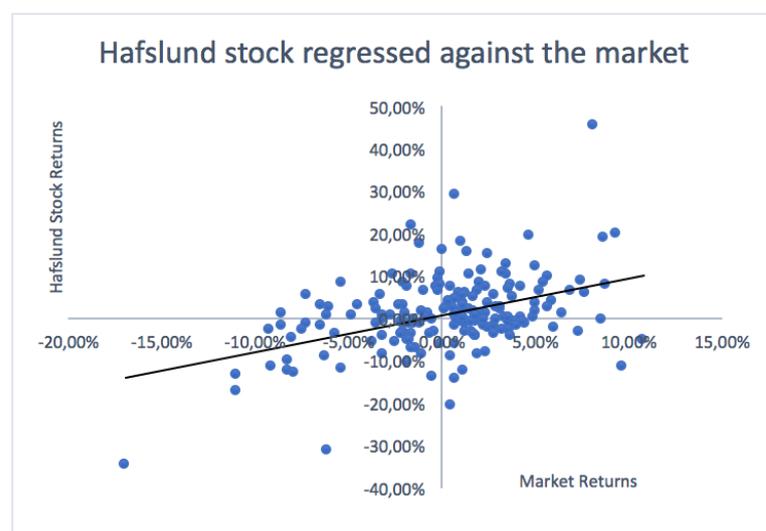


Figure 17: Exhibits the regression of the stock returns against the market returns

Figure 17 illustrates the regression in a scatter plot diagram. The solid line is given by the regression model and the slope is expressed by the beta of 0.862. To get a more accurate beta estimate, the stock's beta is regressed in a ten- and five-year period. Ultimately beta raw is estimated using equation 2.

Table 8 illustrates the results from the regression model and the significance of the beta parameters during the different time-periods. As the number of years in the regression decreases, the significance of the beta parameter also decreases. Nonetheless, the beta is highly significant in all the estimates.

Statistic analyzes of beta	
Beta regressed over 15 years	0,862
t-stat	6,264
Beta regressed over 10 years	0,948
t-stat	5,902
Beta regressed over 5 years	0,592
t-stat	3,924

Table 8: Overview of the significance in the beta estimates

Further, the capital structure of Hafslund is removed, and replaced by the capital structure of Company X. The same approach is applied on the industry beta, thereby levered with Company X's capital structure. The industry beta was obtained from Aswath Damodaran's home page (Pages.stern.nyu.edu, 2017).

The data needed to de- and re-lever the betas were gathered from the annual reports of 2014 from Hafslund and Company X. Finally, the thesis will use an average of all these betas as input in the CAPM, taking the Bloomberg adjustment into consideration:

$$\beta_{adjusted} = \rho * \beta_{raw} + 1 * (1 - \rho) \quad (11)$$

where ρ has the commonly used weight of 2/3. The Bloomberg adjustment is a simplification of the method derived by Marshall E. Blume. He showed that there was a consistent tendency for a portfolio with either an extremely- high or low estimated beta in one period to have less extreme beta in the next. The estimated betas exhibit a tendency to regress toward the mean of all betas, namely the market beta, 1. Companies with either extremely high- or low beta, tend to have less extreme risk characteristics over time (Blume, 1975).

Table 9 displays the estimation of the different betas used to derive the beta estimate. The average estimated beta used as an input in CAPM is **0.844** for Company X.

Beta input	Beta raw regressed	Unlevered	D+E/E Company X	Relevered	Bloomberg adjusted
Regressed beta 15 years	0,862	0,407	1,765	0,719	0,813
Regressed beta 10 years	0,948	0,448	1,765	0,791	0,861
Regressed beta 5 years	0,592	0,280	1,765	0,494	0,663
Beta formula	0,915	0,432	1,765	0,763	0,842
Cov(S&P, Hafslund)	0,00173				
Var(M)	0,00190				
Industry (power, Europe) beta		0,6	1,765	1,059	1,039
Average beta used in analysis	0,844				

Table 9: Exhibits the process in which the average beta was estimated

4.5.1.2 The Market Premium

The equity risk premium, commonly known as the market premium, is a key component in every valuation. Thus, one should not only look at why it matters, but also the factors influencing the level at any point in time. The market premium reflects fundamental judgements about how much risk that is observed in the market, and what price should be attached to this risk. The process affects the expected return on every risky investment and the value estimated for that investment. Consequently, it makes a difference in how wealth is allocated across different asset classes. The market premium is the price that investors demand for the average risky investment, and by extension, the discount that they apply to expected cash flows with average risk. When market premiums rise, investors are charging a higher price for risk and will pay less for the same set of risky expected cash flows (Damodaran, n.d.).

The market premium constructed in this thesis is based on an average of two different market premiums. First, the implied premium in the Norwegian economy is gathered from the home page of Aswath Damodaran (Pages.stern.nyu.edu, 2017). Second, the other premium is estimated using relative standard deviation, based on the S&P 500 index and OSEBX. We obtain the implied market premium in the US and use relative standard deviation to make it fit with the Norwegian economy. Equation 12 illustrates this process. The factor obtained from this process is multiplied by the market premium in the US.

$$Relative \sigma(NOR) = \frac{\sigma_{US}}{\sigma_{NOR}} \quad (12)$$

Table 10 illustrates the measures used to estimate the market premium. The average market premium used as input in the CAPM is **5.2 %** in the Norwegian market.

Market premium pr January 2015	
Implied Norway/Europe(observed)	6,20 %
Equity Risk Premium Using relative standard deviation	
Relative standard deviation	Country X = Std US/STD x
US Std(S&P 500)	15,21 %
NOR Std(OSEBX)	22,17 %
Relative Std NOR	0,686
Implied Risk premium US (observed)	6,12 %
Equity Risk premium(calculated)	4,20 %
Market premium average used in CAPM	5,2 %

Table 10: Exhibits the process in which the average market premium was estimated

The implied market premium in the Norwegian economy is greater than the one in the US and is most likely caused by a higher volatility in the Norwegian market, with reference to the OSEBX and S&P 500 index.

4.5.1.3 The Risk-free Rate

The risk-free rate is the certain expected rate of return on an investment and is commonly measured as the current market interest rate on a default-free (usually government) security, such as Treasury bonds. It is worth noting that the risk-free rate will vary across currencies because the expected inflation rate is different with each currency (Damodaran, 2008, p. 101).

As a *rule of thumb*, the choice of maturity on a risk-free bond should reflect the life span of the project to be analyzed. The maturity of the project under assessment is 23 year, meaning that the maturity of the risk-free bond should be about 30 years. The longest maturity on Norwegian Government bonds is 10 years, whose yield we use as an approximation to the project's risk-free rate of return. When evaluating government bonds with different maturities it is common to discuss the liquidity preference hypothesis. This states that the ex-ante return on government securities is a monotonically increasing function of time to maturity. Consequently, conditional on all

available information, the expected yearly return on a government bond with 30 years to maturity should exceed the expected yearly return on a 10-year government bond. The intuition behind this argument is that longer term bonds are *riskier*; meaning, they are more sensitive to interest rate changes than shorter term bonds (Boudoukh et al. 1999). Individuals need to be compensated for holding these *riskier* bonds, hence a 30-year government bond will probably bear some liquidity risk, thereby not being entirely risk free.

This supports the choice of using a 10-year government bond as opposed to the 30-year government bond. The average monthly rate of return per 1. January 2015 on a 10-year Norwegian Government bond is **1.45 %** (Norges bank, 2017), which will function as the risk-free rate used as input in the CAPM. By computing the CAPM using equation 3, the cost of equity derived is approximately **6%** for Company X.

4.5.2 WACC

The WACC is the weighted average of cost of- equity and debt, where the tax shield is taken into account. This model presents the cost of capital needed to discount the free cash flow to the firm. The tax shield lowers the cost of capital, and since the tax effect is considered in the denominator of the model (exhibited in equation 1), the free cash flows in the numerator of the model must also be adjusted for tax effects (Miles and Ezzell, 1980).

In order to compute the WACC, the cost of debt must be obtained. Modigliani and Miller argue that fixed debt levels encourage tax shields to be discounted using the required return on debt (Fernandez, 2007). Company X is investing in a wind power project and we assume fixed debt levels. This means that the thesis will use the required return on debt to discount the tax shield. The interest payables in 2014, were 98.4 MNOK, stated in the annual report 2014, note 8 (Company X, 2015). By dividing this sum with the interest-bearing debt, we obtain an approximation to the cost of debt, roughly **4 %**. However, all the interest-bearing debt in Company X is due to bond issues, thus, the correct cost of debt will be the risk-free rate plus the bond spread, where the company's default risk is taken into account.

Had Company X been publically traded, it would be fairly easy to obtain the accurate cost of debt. Aswath Damodaran suggests a method in order to approximate a cost of debt using a *synthetic* rating and a default spread that goes with this rating. The link between interest coverage ratios and ratings was developed by looking at all rated companies in the US, and the default spreads are obtained from traded bonds. Damodaran states that a firm with an interest coverage ratio greater than 4.5 has a credit rating of A3/A- (Pages.stern.nyu.edu, 2017).

$$\text{Interest coverage ratio} = \frac{EBIT}{\text{Interest Expense}} \quad (13)$$

The interest coverage ratio is given by equation 13 and Company X has an interest coverage ratio of 4.57, which consequently yields a credit rating A3/A- and a spread of 1.10% for a 10-year corporate bond. The cost of debt is given by the risk-free rate plus the spread, which is roughly **2.6%**. The cost of debt input in the WACC is calculated as the average of the two approximations above. This generates a cost of debt equal to **3.3%**.

Company X finances their projects through Company X Group, which means that they do not need to issue more bonds in order to finance the projects. However, the Company X Group's capital structure is consisting of approximately 57% equity and 43% debt. Since no additional debt is taken on when financing the project, this argument supports the assumption of fixed debt levels and equal risk in the projects. The allocation of debt and equity used to compute WACC will be 43% and 57% respectively. Table 11 shows the results from the computation of the cost of capital. As observed, the cost of equity is greater than WACC because it is associated more risk with the equity cash flow. If Company X increases their debt, the cost of equity will increase, leading to a decrease in the cost of capital to the firm (WACC). The equity becomes riskier as the debt increases, while the WACC decreases due to the tax shield.

Cost of Capital	
Cost of Equity (CAPM)	5,8 %
Cost of Capital (WACC)	4,4 %

Table 11: Illustrates the cost of capital based on the theoretical framework

The cost of capital used in the analysis obtained from WACC, equals **4.4 %**.

4.5.3 The Approach to Cost of Capital

As illustrated in the previous section, there exist practical difficulties in estimating the cost of capital. From this, it follows that there will arise some deviations between theory and practice when estimating the cost of capital.

Given that the known assumptions were present, the theory would be perfect to explain how to compute the cost of capital. However, the theory also discusses methods to work around these difficulties. The first problem that arises is the fact that Company X is not traded on any stock exchange, which creates a problem in calculating the beta. This issue was solved by using a proxy-company, registered on the stock exchange. The thesis de-levered the proxy-company's beta, and re-levered it using Company X's capital structure. This approach is aligned with the approaches used by the management in Company X (Project manager, 2017).

The second problem relates to issues regarding diversification. Usually when working with private firms, the investors holding the equity are not fully diversified which is the case of Company X. To disregard this assumption is common, and consequently accept that every assumption of CAPM cannot hold.

There exist some deviations from the raw finance literature and the assumptions taken to estimate the cost of capital. However, an increased amount of literature describes ways to work around complications regarding the strict assumptions underlying the CAPM. This suggests that the theory evolves to adapt to the practical application of the models and the thesis does not find great deviations between how Company X estimates the cost of capital and how the estimation is done in this thesis. Moreover, the cost of capital obtained by Company X is somewhat greater than the one obtained in this thesis, and since the two approaches are similar, it is obvious that the investors of Company X find it necessary to compensate for additional risk. This additional risk may arise from the fact that the investors keep most of their wealth in Company X, and are thereby concerned with the total risk of the firm. This will be discussed extensively in section 5.4.

4.6 Net Present Value

The net present value represents this investment analysis' overall conclusion. In both the theoretical- and the practical analysis the wind farm project results in a positive net present value.

As shown in table 12, the theoretical NPV is larger than the practical NPV and the IRR is lower mainly due to: different cost of capital, different price estimations and the use of different depreciation methods. Further discussions regarding these differences will be discussed extensively in section 5.

NPV		
Method	Theoretical approach	Company X
NPV	11 691 090	4 368 000
IRR	5,22 %	6,41 %

Table 12: Illustrates the value of the project through both the theoretical- and practical approach

4.7 Sensitivity Analysis

To test the quality of the investment, this sensitivity analysis will point to two uncertainty factors relating to the amount of electricity produced and different cost of capital-inputs.

Ideally, we would test the sensitivity of price in this analysis, as future prices for electricity and green certificates are among the factors with the highest uncertainty. That being said, we do not test the price-input because prices were extensively analyzed in section 4.1. Filtering of raw-data sample were done to remove long-term seasonality and adjustment for infrequent price jumps. Thereafter, GARCH was applied to better capture the dynamics of the time series conditional variance, before running this through an AR (1) process with a random walk component. Instead of increasing the future prices using a growth rate, the prices change because we use the average price of thousand simulations.

The next important input in the analysis is the amount of produced electricity, measured in MWh. The volume is a function of the number operating hours, times the effect each

turbine deliver and total number of turbines. The average number of operating hours predicted during a year is approximately 3000 hours, being a passive estimate (Project manager, 2017). For this analysis, the base-case scenario will be 3000 operating hours and the worst-case- and best-case scenario will be 2500- and 4000 hours respectively. We increase the operating hours more in the best-case scenario because it is more likely that the average yearly operating hours will be above 3000 hours. The analysis will display all the values acquired from the project by obtaining different operating hours each year.

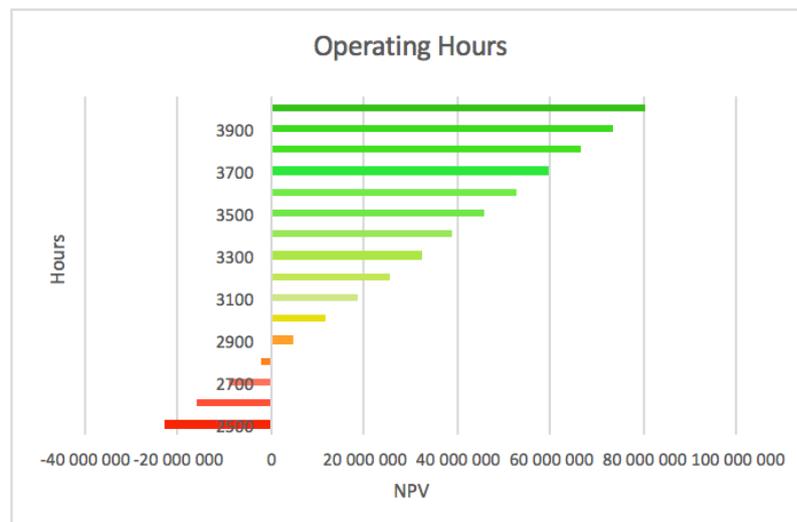


Figure 18: Illustrates the NPV of the project through a sensitivity analysis with different inputs of operating hours

Figure 18 illustrates the sensitivity in operating hours, ranging from dark red (worst-case) to dark green (best-case). The best case of 4000 operating hours provides a project value of approximately 80 MNOK. The worst-case of 2500 operating hours provides a project value of approximately -22.5 MNOK. Finally, the base-case of 3000 operating hours yields the known project value of 11.6 MNOK, illustrated in the yellow line. However, it is worth noting that the break-even number of operating hours is approximately 2830 hours. From this it follows that company X cannot afford an average decrease in operating hours more than 170 hours each year, other factors being equal. Following the statement from the project manager, the probability of producing less than 3000 hours yearly per turbine is relatively low. This implies that Company X holds a solid buffer, in the sense that operating hours probably will exceed 3000 hours, rather than fall below.

Another factor which affects the project value substantially is the cost of capital. As mentioned, the cost of capital chosen in this thesis is lower than Company X's. The IRR of this project is approximately 5.2 %, meaning that a cost of capital greater than 5.2 % yields a negative NPV. Figure 19 illustrates different project values with their respective cost of capital-inputs.

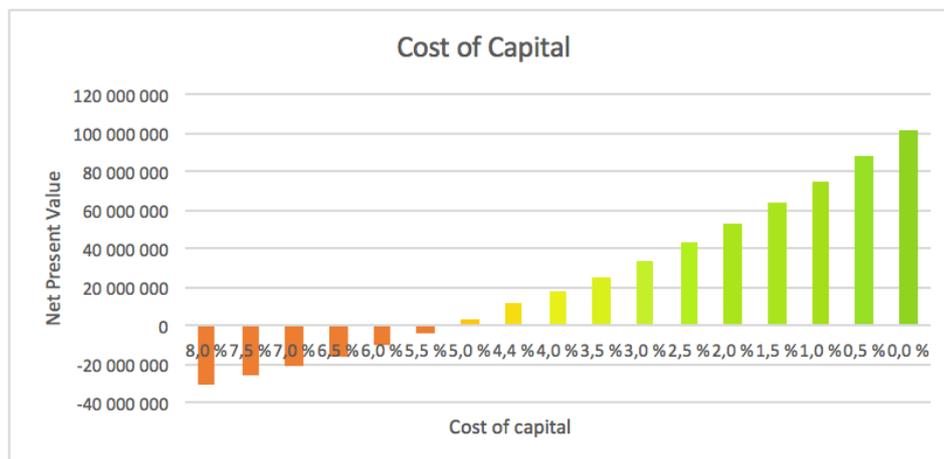


Figure 19: Illustrates the NPV of the project through a sensitivity analysis with different inputs for cost of capital

The values differ substantially by introducing different estimates regarding the project's risk. The yellow column displays the base-case scenario, with a cost of capital of 4.4 %. By introducing a cost of capital of 6 %, which is approximately the same rate as Company X uses, the project will consequently yield a negative NPV, as $IRR < 6\%$. On the other hand, Company X operates with an IRR of 6.41 %, resulting in a positive NPV after all. This is mostly due to the choice of depreciation methods.

It may be interesting to investigate the cash flow by using the price estimations and tax depreciations applied by Company X as inputs in the theoretical framework developed by this thesis.

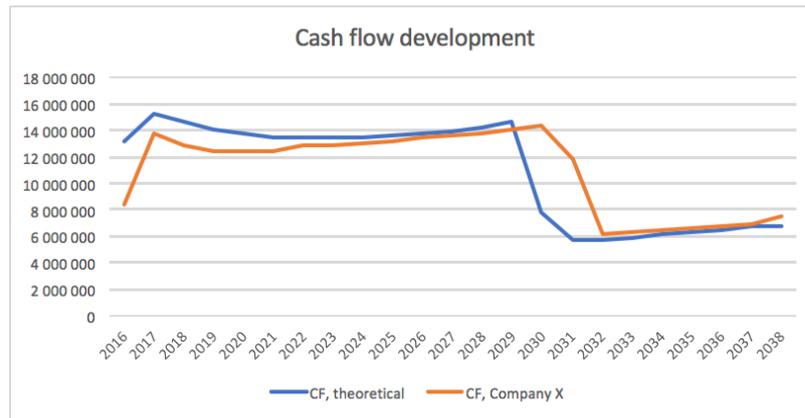


Figure 20: The cash flow development of both Company X and the theoretical approach, using tax depreciations

Figure 20 illustrates that the cash flow between our analysis and the analysis of Company X becomes more similar than what figure 16 illustrates. Following from applying tax depreciations, the NPV of the project will increase as the IRR of the project increases due to a higher cash flow.

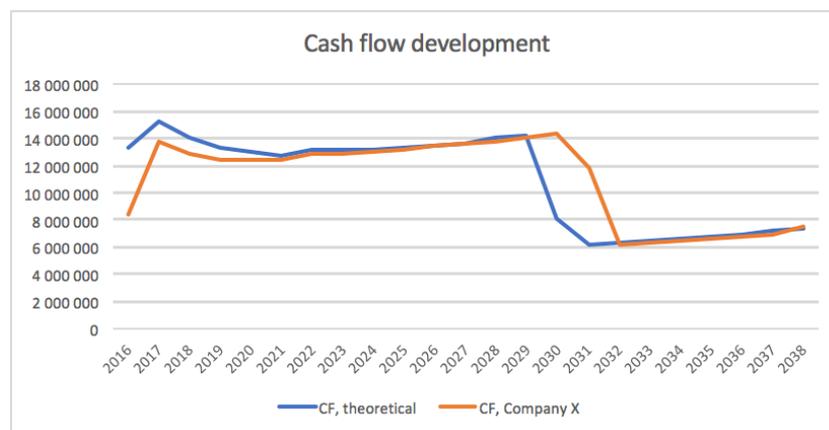


Figure 21: The cash flow development of both Company X and the theoretical approach, using tax depreciations and the same price estimations as Company X

By introducing the price estimations of Company X into the analysis, we see from figure 21 that the cash flow development between Company X and the theoretical approach is roughly the same throughout the project period. The exceptions arise at the beginning of the period and when green certificates cease to exist. This is due to deviant assumptions regarding production in the beginning of the period, and the frequency in which the green certificates are set to expire.

If we were to use tax depreciations and the same price estimations as Company X in our analysis the IRR of the project would increase by 1%, and consequently the NPV will increase, all else being equal. Applying approximately the same cost of capital as Company X, the project value in our analysis will decrease and becomes somewhat similar to the estimated NPV of Company X, illustrated in table 12. Price differences will be discussed in section 5.2, where the thesis examines causes to different price estimates.

Finally, a sensitivity analysis on the marginal loss rate and the regulatory costs is undergone in appendix 3.1. Results show that a decrease in the marginal loss rate and regulatory cost rate naturally increase the NPV of the project. These findings are not that interesting, and are evidently self-explanatory, which will not be discussed further.

4.7.1 Simulation of the Project

Results until now indicate that the project value varies a lot between the worst-case- and best-case scenario. However, it may be beneficial to simulate the project value around the base-case scenario of 3000 hours. Simulations provide a way of examining the consequences of continuous risk, through the lifetime of the project. To the extent that most risks in the real world can generate hundreds of possible outcomes, a simulation will provide a better picture of the investment risk (Damodaran, 2012, p. 908). Considering number of operating hours per turbine being the greatest uncertainty factor, disregarded the price development, we use this as the input variable in the simulation. This is because the relationship between price and volume is lesser correlated in our case due to the manufactured volume of Company X does not directly affect the price in the market.

Assuming that operating hours will be close to normally distributed, clustering around a mean in changes of 0 % and a standard deviation of 3%. The hypothetical changes in operating hours are created from random draws by a stochastic process (Jorion, 2006, p. 266). The analysis conducts 1000 simulations on operating hours based on a Geometric Brownian Motion as the prices earlier. However, in this simulation we need to make strong assumptions regarding the distribution of the operating hour variable. The variable is assumed to be close to normally distributed, but this is not necessarily the

case. On the other hand, a normal distribution of the project will be assured by the *law of large numbers*. If the assumption regarding the distribution is wrong, it will not have a great consequence, seeing as the simulation of the project is run in order to validate our base-case scenario.

Figure 22 illustrates the normal distribution obtained from running the simulation on the project. As one can observe, the mean of NPVs from the simulation is clustered around 11.7 MNOK.

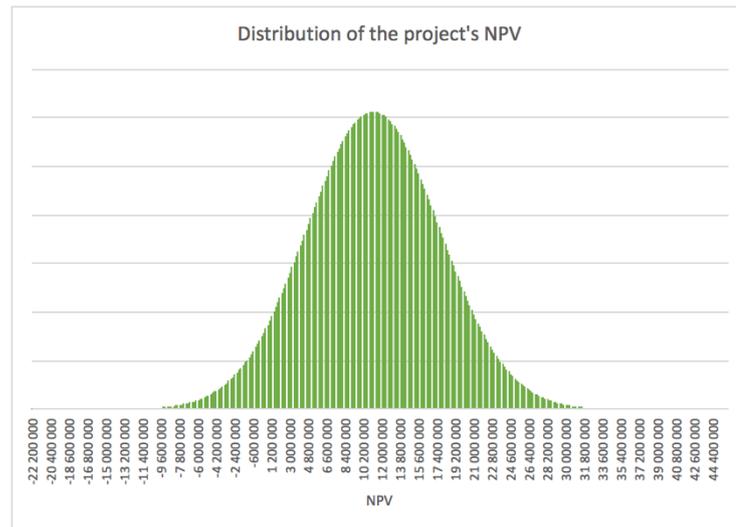


Figure 22: Exhibits a normal distribution for the project's NPV, based on 1000 simulations

In table 13 we summarize the statistics obtained from the simulation of NPVs from the project. As commented above the NPV mean is approximately 11.7 MNOK, which is approximately the same as the NPV obtained from the base-case analysis. The standard deviation from the simulation is large and implies that the NPV may vary substantially depending on changes in operating hours. That being said, the kurtosis from the simulation is very small, indicating that the probability of extreme events is very low.

Summary statistics from Simulation	
Mean(NPV)	11 738 174
Std Dev(NPV)	6 515 180
Max	33 643 089
Min	-8 471 972
Median	11 854 301
Skewness	-0,0437
Kurtosis	0,1294

Table 13: Summary statistics of simulated NPV

Based on the simulation from figure 22, it is reasonable to draw the conclusion that a NPV of approximately 11.6 MNOK is a likely outcome. Nonetheless, estimating probabilities for each scenario is vital to illustrate the bigger picture. The test observer is given by:

$$Z = \frac{x - \mu}{\sigma} \quad (14)$$

where x is the observed NPV for each scenario in the analysis, μ is the NPV mean and σ is the standard deviation from the simulation. Next, the normal distribution is obtained from this test observer, $N(Z)$, and estimates the probabilities:

$$\Pr(\mu \geq x) = N(Z),$$

since the test observer in each scenario is greater than zero. However, this may differ between each simulation run because different values are obtained in the NPV mean. The probabilities for each scenario and the associated NPVs are illustrated in table 14.

Scenario	Worst-case	Base-case	Best-case
Probabilities	0,333	0,333	0,333
NPV	-22 584 869	11 691 090	80 243 007
E(NPV)	23 116 409		

Table 14: Expected NPV based on three different scenarios and their respectively probabilities

The probabilities assigned to each scenario is 33.33 %, since $N(Z)$ to each scenario was approximately 50 %. This is aligned with the discovery of *the law of large numbers* by Jacob Bernoulli. That the probability of heads (tails) will approach 50 % with an increasing amount of coin tosses.

The expected NPV from all scenarios is 23.116.409 NOK. The reason as to why the expected NPV is almost twice the value from the base case, is because of the increase in operating hours. Either increasing or decreasing the operating hours, will have a significant impact on the net present values. From this we observe that the value from this project is highly sensitive to the operating hours, other factors being equal. However, Company X is comfortably certain that the average operating hours each year will be 3000 hours or more, based on competent industry knowledge.

4.8 Real Options

The whole idea of including real options to this investment project were primarily to illustrate the inherent flexibility that arises by unfolding the many opportunities in Company X's decision-making process. However, we gradually realized that applying the most common real options to this investment analysis had its challenges due to lack of flexibility-opportunities in the project.

Real options provide management with an opportunity to adjust- or abandon established plans, and thereby create flexibility in a state of uncertainty. To the extent that the flexibility is worth implementing, it needs to provide the user with additional value, following two unambiguous pay-off structures.

First, the option to abandon would follow an American put, meaning that the project manager got the right to abandon the project at any time. Following the pay-off structure:

$$Put_{payoff} = \max(X - P, 0)$$

where X is the exercise price and P is the price of the underlying asset, in this case the project. An option to abandon would be relevant in terms of a long-term decline in electricity prices. However, there is actually no value in abandoning this specific project because a substantial amount of total costs was irreversible at the time the investment decision was made. In addition, operating costs are relatively low, which consequently leads to a more negative NPV if Company X chooses to liquidate their project. Not to mention the fact that the demand for used, yet functional wind turbines would ultimately cease due to equal market conditions between actors. These arguments illustrate that an option to abandon yields no flexibility to Company X, hence, the exercise price will ultimately be zero. As a matter of fact, maintaining production of wind power seems to be Company X's only alternative in any market scenario.

From another perspective, Company X could possibly want to expand their future production of wind power through an option to expand. The characteristics is similar to an American call with the following pay-off structure:

$$Call_{payoff} = \max(P - X, 0)$$

P have the same definition as in the American put and the exercise price (X) in this case is the reinvestment expenditure of additional wind turbines, in order to expand the project. The purpose of an expansion option is to increase the potential upside from the investment and decrease the possible downside. There exist however, some practical challenges following an expansion option. Every producer must acquire concession rights to build a wind farm, where it dictates the allowable amount of wind turbines. This implies that a producer cannot exceed this amount without applying for an extended concession. Moreover, the green certificate scheme is set to end in 2021, which will hinder the profitability of an expansion beyond this point. The consequence of not receiving the green certificates is that the upside potential narrows, following that the future profitability will be substantially lower. Seeing as the value of the underlying asset (project) will decrease without the green certificates, the pay-off of an expansion option will most likely be zero.

A third option for Company X would ultimately be an option to delay the investment, following the same attributes as an American call. A possible scenario in which a delay option could come in handy is if uncertainty is clarified within the near future. For example, uncertainty in number of average operating hours yearly or clarification on a vital political factor concerning the project. It is worth noting that the concession right lasts for 5 years, thus, it will not be possible to delay beyond this point. From the sensitivity analysis in section 4.7, we observed that the project value is highly sensitive to the number of operating hours, with a break-even point at 2.830 hours yearly per turbine, other factors being equal. An opportunity could be to delay the project and potentially invest if precise and positive data prove to deliver wind estimates greater than break-even. In this way, the delay option will provide more value, adding to the original NPV (negative), where the possibility of increasing the operating hours are implemented. This follows the logic from a financial option, where high volatility increase the value of the option. The potential gain is greater and the costs to access these gains remain the same. That being said, the estimated operating hours per turbine are according to the project manager a cautious measure of 3000 hours yearly, with a high degree of certainty. In this case, the delay option provides no additional value to the project and will in fact contribute to a reduction in NPV, due to the time value of money.

Given the arguments above, integrating flexibility in the decision-making-process does not provide proper additional value. In our opinion it is therefore advisable to not to implement real options onto this project. The thesis is therefore forced to search for other real options to capture both flexibility and valuable opportunities. This gives rise to another interesting idea, which merely concerns the company in general and not this specific project.

Company X can gain flexibility by exploiting the applications of concession rights. Different concession rights in different strategic locations can be kept in a portfolio and renewed every 5 years. If market conditions improve, the company can choose to initiate projects instantaneously, since the concession is already established and competitors focus are on other renewable energy sources. This leads to a first-mover advantage, since competitors need to go through the concession right-process. Costs related to a concession right are merely the time put into- localizing a possible area of production and the application process to the Norwegian government. In other words, this can be categorized as the option premium, and it is relatively affordable as opposed to the possible gains that could arise. The potential gain in which this opportunity can provide, arises from the expectations that investments in wind power would severely decrease after 2021 as the market becomes mature, and the green certificates ceases (Project manager, 2017).

5. Analytical Findings

5.1 Introduction

The main objective of this section is to summarize and elaborate on findings from the analysis undergone in section 4. By investigating specific theoretical- and practical differences up against established literature, we are able to confirm whether observed deviations are considered unique or simply normal. That being said, it is worth mentioning that our study is solely based on one investment analysis, and no unambiguous conclusion can be drawn based on our findings alone. However, deviations may indicate that theory is not a black- and white subject.

In general, there are contradictions to whether there actually exist a relevant gap between theory and practice today. Several research papers through the recent decades have covered this topic, with the intention to reveal if the theory-practice gap has narrowed through time. Terje Berg (2015) points out that theory tends to be either too judgmental or not applicable, which again contributes to the fact that practitioners rarely find academic articles and journals that valuable. Among the many methods used by businesses today, not all has its origin from academic textbooks. Some methods have grown out of subjective experience inside a company, or acquired from consultants. With this in mind, Berg emphasize the importance that research must not end up being a closed source between researchers, but rather work in closer collaboration with practitioners.

To bridge the gap between theory and practice, Baker et al. (2011) suggests an increase in academic surveys covering practitioners, and journals publishing the results based on the practical findings. This give rise to two potential benefits; First, properly designed surveys will shed light on conceptual hypotheses and relative usefulness of various theories. Second, a continuous dialogue between academics and practitioners help set the correct agenda for important subjects in the future. Despite these benefits, a survey approach will only capture trends and general overviews. That is also why this thesis chooses a different, more specific approach to capture internal mechanisms behind possible theory-practice gaps.

5.2 Revenue

The first thing worth noting in the analysis undergone in section 4 is concerning revenue. There is no straight-line answer regarding if Company X's revenue analysis deviates from textbook standards, but it certainly deviates from the methods used in this thesis. On that note, the findings revolve around how the two different methods applied deviates from each other and if they yield varying results.

The price estimation of electricity- and certificate prices are as mentioned in section 4.1.4 done in a THEMA model, which is based on dynamic programming. The THEMA model can be characterized as a highly-sophisticated model built on different scenarios and price drivers that continually changes its output based on chosen fundamental parameters (coal price, oil price, wind- and water levels, etc.) in the setup (Project manager, 2017). These parameters are mainly classified according to the sequential decision process as either stochastic or deterministic. The model simulates 70 different scenarios/outcomes for long term price estimation, and use a mix between median and average as a basis for setting the expected price path. However, a problem arises under long-term price forecasting because deterministic parameters are not available. On that note, Company X is mainly relying on the stochastic parameters when analyzing price for future investment projects, which is aligned with the revenue analysis done in this thesis.

There are two main differences between the methods at hand. First, Company X applies several fundamental price drivers rather than only historical electricity prices. Second, the forecast is based upon only 70 simulations, whereas the thesis uses an approximation to the typical Wavelet transform-GARCH-ARMA method. Where Wavelet has been replaced with HP-filter and instead of ARMA, the thesis uses an AR(1)-process with the special case of random walk, which is thoroughly explained in section 4.1.1. Rafal Weron (2014) have done extensive research on the topic of electricity price forecasting to examine if a best practice actually exists. The first thing to consider is that electricity is a non-storable commodity, with high dependency towards weather conditions, and requires a constant balance between production and consumption. Weron also states that this research area is not yet matured, which support our findings that different methods are used to forecast electricity prices, and further complicates the process in establishing a common practice (Weron, 2014).

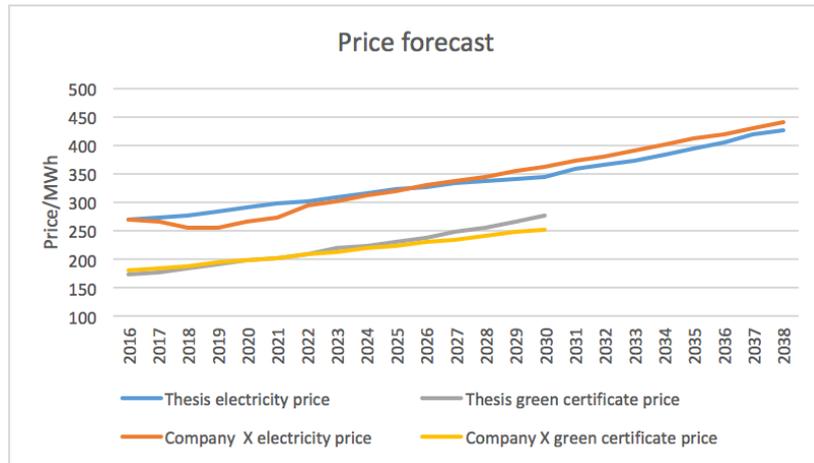


Figure 23: Illustrates the forecasted electricity price- and green certificate price development for the two different approaches

Regarding the results from each of the two methods, figure 23 illustrates the forecasted development in prices both for electricity- and certificate prices. As shown, both methods yield somewhat the same results for both the level- and development of prices. However, the THEMA model estimates a decline in price the first years, which can be explained by the heavy use of several fundamental price drivers. These drivers are known for explaining short-term price changes, as opposed to the Wavelet transform-GARCH-ARMA method. Over time, the differences between the two methods indicate less deviation and they follow a close to linear price increase. Consequently, this illustrates that two different methods to forecast future electricity prices yield relatively the same price estimates. It is also aligned with Weron's statement, that there is no established practice for how to best forecast electricity prices.

5.3 Costs

The costs associated with this investment project are as mentioned in section 4.2 dominated with a large share of fixed-, and industry specific costs (manufacturing etc.). Questioning Company X's industry knowledge in regard to cost objects and standardized measures are therefore considered unnecessary. There are however some specific findings worth highlighting in regard to cost distribution over the investment period. The variable costs are approximated to be around 29.03 %, which make them less relevant for the decision-making process as a whole. That being said, having realistic variable cost levels could be the difference between accepting- or rejecting a marginal investment opportunity, due to the inherent flexibility.

5.3.1 Marginal Loss

By specifically taking a closer look at the estimated costs from marginal losses, the project manager explains that there is no elaborate analysis behind halving the percentage of marginal losses in 2019 and keeping it constant over the project lifetime. The percentage rate is likely to decline, but it is highly uncertain when or by how much (Project manager 2017). We find it appropriate to deviate from Company X's estimates, mainly because marginal losses fall under the category of continuous improvement, as both production- and transportation costs will reduce gradually over time. Not to mention that technological improvement and internal knowledge are the main drivers for long-term cost reduction. However, since the rate of reduction is unknown and hard to predict, it is suitable to smoothen out the cost reduction as opposed to Company X.

The theoretical approach refers to continuous improvement in many ways, whereas improved internal routines can be seen as learning cycles. Through time, it is inherent in any company to observe various strategies, evaluate processes and take actions that will lead to cost reduction for the next period. A typical hallmark by measuring learning curves precisely is to predict when they occur. With this in mind, Zangwill and Kantor (1998) find it convenient to smoothen out improvement instead of overanalyzing less irrelevant parts of the analysis. Engineers at Massachusetts Institute of Technology (MIT) have devised a formula for estimating how fast a technology is advancing based on information gleaned from relevant patents. The researchers found that technology in wind turbines appear to be improving at slower rates than the average, which substantiates the fact, that smoothening out cost reduction is a more realistic approach (Abazorius, 2015).

Setting the marginal loss rate more pessimistic than Company X will in fact reduce the overall net present value with approximately 2 MNOK, but in regard to theory and recent studies done at MIT we see it fit to postpone the marginal loss rate reduction.

5.3.2 Depreciations

In section 4.2.1 we concluded that there was no gap between theory and practice in regards to Company X's use of tax depreciations (acceleration method) and the use of straight-line depreciations as this thesis use. However, an interesting discussion arises between the two varying methods used in regard to what depreciations actually should reflect. First, is it preferable to make sure that depreciations follow the cash flows or the actual loss of benefits? Second, since both methods are aligned with theory, do their results differ significantly from each other?

The first question addresses information quality and how Company X wants to reflect value over the investment period. Jan Bergstrand has conducted extensive research on how capital costs (depreciation and interest rates) may be allocated, and in this case, it is therefore appropriate to view his findings merely on depreciations. Normally, depreciations can be separated into several different methods, whereas our two methods are by him called tax depreciations and management accounting depreciations (Bergstrand, 2009, p. 263-284). For tax purposes, the depreciation period is often set as short as tax authorities allows, which consequently yield smaller tax payments in the beginning and declining depreciation cost. However, this thesis is applying the management accounting depreciations, which has its main- advantages and disadvantages (Bergstrand, 2009).

Advantages	Disadvantages
<ul style="list-style-type: none"> • Illustrate the correct loss of benefits • Expedient if inflation is low • Easy to communicate to an organization 	<ul style="list-style-type: none"> • High inflation lead to a jump in depreciations when reinvesting • Do not always follow the estimated cash flow

Table 15: Advantages and disadvantages by using straight-line depreciations

Objectively, a wind farm investment is long term and has a high certainty of operating hours throughout the estimated lifetime. Table 15 shows that applying management accounting depreciations is therefore a good tool in regard to reflecting the true loss of

benefits. Tax depreciations on the other hand, overestimate the loss of benefits in the beginning of the project period.

In terms of inflation, both methods capture this in the cost of capital and future reinvestments will therefore cause depreciations to rise significantly, due to an increased investment amount. This is however a case for both methods at hand, and we see it fit to merely focus on their differences.

Ayres (1994) writes about the term earnings quality and how different actors perceive this topic. By using two similar companies with the two specific depreciation methods above, he is able to illustrate their differences. For instance, companies using straight-line depreciations will have a significantly lower P/E (Price/earnings) - ratio than companies using accelerated depreciations the first years, other factors being equal (Ayres, 1994). Without focusing too narrowly on this ratio alone, it is still worth mentioning what consequences these deviations may indicate. From a growth perspective, Penman (1996) explain that companies with high P/E are associated with relatively high subsequent earnings growth. Whereas low P/E are associated with relatively lower subsequent earnings growth. If this is the case, is hard to determine without examining the strategic growth opportunities undergone in section 3.

There are especially two main factors that favor both positive- and negative growth opportunities for the wind turbine market. The power cable cooperation with England will remove the power surplus and contribute to both an increase in demand of electricity and a more supply predictability (TU, 2014). Nonetheless, Company X's project is highly dependent on the steady flow of electricity certificates to be profitable. If the market gradually overinvests until 2021 to capture the certificate benefit, it could contribute to an excessive supply side, which ultimately has a massive impact on the green certificate prices. Whether both these scenarios will have the explained impact is uncertain, but assuming a very strong growth seems unlikely. On that note, following Ayers (1994) and Penman (1996) arguments, it is more suitable to apply the straight-line depreciation method.

The second question addresses if the two different methods used yield different results. From figure 15 one observes that a deviation of that size will have an effect on the value

of the project. Tax depreciations have the ability to build up tax savings the first years, and considering the time value of money, this has a huge positive effect on the cash flow. In fact, the net present value- and the internal rate of return increases with respectively 10 MNOK and 1%, other factors being equal. This helps explaining why companies prefer this depreciation method for financial purposes, because it simply illustrates a more profitable point of view.

The management accounting method can therefore be seen as a more realistic approach to capturing the true loss of benefits from the investment. This indicates that the two methods are appropriate in their own way. Company X's method exhibits a more profitable and more lucrative perspective for investors, as opposed to the management accounting method, which is preferable to use for internal- and informative purposes.

5.4 Cost of Capital

The cost of capital has been approximated using a theoretic framework from the finance literature, and the assumptions made are thoroughly discussed in section 4.5.3. Our analysis calculated a cost of capital of 4.4 %. Company X operates with a higher cost of capital since the management and the owners require a higher rate of return to initiate the project. The cost of capital was discussed extensively with the project manager, and it was stated that they use a cost of capital between 5 % and 8%, which compared with our calculation is slightly higher.

5.4.1 Why Cost of Capital Deviates

The methods Company X uses to obtain the cost of capital is very much alike the methods applied in this thesis, whereas Company X also uses a proxy in order to calculate the project beta, which is assumed similar to the company's equity beta. However, Company X obtains a higher cost of capital than what is obtained in the thesis. One of the reasons are that Company X has invested in previous projects very much alike the project used in this analysis, and based on experience, increased the cost of capital in addition to what the models dictate. As we see it, following reasons may cause this additional return. First, Company X perhaps added a small cap premium to the

required equity return. Secondly, firms not traded in the market usually have difficulties of freeing capital such that the investor cannot sell their stocks as easily as the ones traded. As a result, investors would want a liquidity premium to compensate for this disadvantage.

Regarding the first reason, PricewaterhouseCoopers (PwC) carried out a survey to obtain insight on the size of the market premium, risk-free rate and small stock premium amongst other measures. The survey participants were analysts and economists with experience from the Norwegian financial stock market (PwC, 2014). The results showed that the most commonly used size of the market premium was 5 % and that practitioners mainly applied a 10-year government bond as the risk-free rate in the Norwegian market. Also, the majority of the participants apply a small stock premium to the required rate of return for small companies (PwC, 2014).

PwC's study corresponds with our approach when it comes to the risk-free rate and the market premium. However, a small stock premium has not been applied to the expected return for small companies. The reasons as to why this thesis does not apply the small stock premium is because the premium of having a positive exposure to the small stock firms minus big stock firms (SMB) has proven to be insignificant since the mid 80's. The size effect was historically enormous during the period 1963-1981 (over 13 % per year), but for the last 16 years of the sample (1981-1997), the size effect was a disappointment for small cap fans.

Further, if firms with market value less than \$5 million are removed from the sample, there is no size effect during the whole sample period 1963-1997. A logical reason to why the size effect disappeared from the data may be that active investors, acting on news of the findings (when SMB factor first was discussed), bid up the price of small cap stocks until the effect was removed. In other words, using this argument, the size effect was not a systematic factor (Horowitz et al. 2000). If that is the case, the additional small cap premium may not be representative since the size effect has disappeared as stated above.

Regarding the second reason, i.e. the liquidity premium, theory tries to approximate the cost of equity calculated in practice, using a liquidity premium between 0 % and 5 %. The typical assumptions behind a liquidity premium is:

- Low trading volume on the stock
- Firm is not traded
- The owners are not, or at least to a less degree, diversified
- The owners have less insight in the firm's value and outlook
- Default risk

(Bragelien, 2015).

By looking at these assumptions it is understandable that Company X may add a liquidity premium on their required return. Company X is not traded nor are the owners well diversified, using the CAPM assumptions. In addition, the project manager stated the difficulty of obtaining outside capital, which leads to greater default risk. Thus, by adding a liquidity risk premium of 2 % to the cost of equity, the cost of capital calculated in this thesis will increase from 4.4 % to 5.5 %, which is more aligned with Company X's cost of capital.

Nonetheless, we choose not to add a liquidity premium in the required equity return, due to several reasons. Company X has obtained the capital needed to front the capital expenditures, while a substantial portion of the costs are fixed and easy to predict. Further, Company X finds it relatively comfortable to predict future sales volume, which is relative high on a yearly average. The Hafslund beta was re-levered with the capital structure of Company X and the equity beta was obtained as an average with the industry beta included. In addition, the debt level of Company X is quite large (still less than the equity), which also reduces the risk in the project due to a greater tax shield. On the other hand, the only crucial uncertainty-variable for the project is the price factor defined as idiosyncratic risk. Especially the electricity certificate price, since the probability of extreme event is present with a kurtosis of 3.510.

Company X seems to use methods that are aligned with what theoretical models dictate, but an interesting assumption could be that previous experience is used to estimate the cost of capital, and that is not supported by theory. Whether this is due to the owner's

intuition, liquidity premium or small cap premium is not easy to determine, because the project manager would not go into details regarding their cost of capital calculations.

Another interesting question to touch upon is what relevant risk is considered to be. There may in fact be other sources of risks in which Company X finds relevant and form the basis of this discussion. Also, it is a lack of theory on the subject regarding companies that are not traded nor diversified. Perfect capital markets and other assumptions underlying the CAPM dominate the theoretical literature, with the consequence that difficulties that are otherwise inherent in adjusting for risk through discount rates disappear.

Damodaran proposes a way in which one can adjust the beta for non-diversification in CAPM. In private firms, the owner is usually the only investor and can be viewed as the marginal investor. Further, the owner tends to have much of his or her wealth invested in the business and does not have the opportunity to diversify, as is the case of Company X. Following this argument, the betas will understate the exposure to market risk in these firms. Stretching this to the limit, he or she is exposed to all risk in the firm and not only the market risk, which is what the beta measures (Damodaran, 2012, p. 672).

Company X, who is owned by the municipalities seldom have a diversified financial portfolio, and are exposed to both systematic as well as unsystematic risks. Thus, there are different incentives when it comes to risk management. Power companies are less regulated, but their investors are less diversified, mostly requesting a predictable cash flow (Berg and Westgaard, 2012). For this reason, it seems likely that the investors in Company X are concerned with obtaining a compensation for bearing the additional idiosyncratic risk.

There is a fairly easy adjustment that allows us to bring this additional risk into the beta computation. Assume that the standard deviation in the private firm's (Company X) equity value (measure total risk) is σ_i and the standard deviation in the market index is σ_m . If the correlation between the stock and the market index is defined to be ρ_{im} , then the market beta can be formulated as:

$$\text{Market beta} = \frac{\rho_{im}\sigma_i}{\sigma_m} \quad (15)$$

The numerator is the portion of the risk in the firm. To measure the exposure to total risk, one can divide the market beta by ρ_{im} . This would yield the following:

$$\frac{\text{Market beta}}{\rho_{im}} = \frac{\sigma_i}{\sigma_m} \quad (16)$$

This is a relative standard deviation measure, where the total standard deviation of the firm is scaled against the market index's standard deviation in order to yield the total beta, given by:

$$\text{Total beta} = \frac{\text{Market beta}}{\rho_{im}} \quad (17)$$

The total beta will be higher than the market beta, and depend on the correlation between the firm and the market. The lower correlation, the higher total beta. It scales the beta to reflect all risk in the firm and not just the portion of the risk that is the market risk (Damodaran, 2012, p. 673). This is done using the same proxy as before, the Hafslund beta re-levered with the capital structure of Company X.

By using the average beta from our analysis, equal to 0.844 as the market beta, and the correlation between the Hafslund stock and the market index, $\rho_{im} = 0.425$. The last equation provides a total beta of **1.985**, which in turn gives rise to an expected cost of equity of 11.8 %. Running this through the WACC provide us with a cost of capital equal **7.7 %**.

This result is in the upper level of the interval the project manager suggested for the cost of capital, and it is seemingly too high. This adjustment assumes that the investor keeps all his or her wealth in the company. This is not exactly the case, as several municipalities own Company X, which also holds capital in other projects (Company X, 2017). One can argue that much wealth is tied up in Company X, and it is therefore appropriate to take an average of the cost of capital without adjustments (as in our analysis) and the cost of capital adjusted for total firm risk. By doing so, we obtain a discount rate of **6.1 %** and the result seems to be more aligned with the decision taken from the management of company X.

Whether to include the adjustment of the market beta is for all intents and purposes a subjective opinion, depending if the firm's investors find it sensible to increase their

compensation. However, in the analysis we choose not to implement the adjustment, largely due to discussion about risk, above. Overall, the calculated cost of capital without *any* adjustments should however be a good enough measure to represent the risk profile in the project. This statement is in accordance with the assumption that a wind farm project is projected to be of low risk/low return as stated in the strategic analysis.

5.5 Rationality

This part is primarily implemented to shed light on the decision-making process and rational behavior. The quality of a decision cannot be determined unambiguously by its outcome, but rather in an interaction with potential alternatives, probabilities and objective data at the time a decision is made (Hastie and Dawes, 2010, p. 16). In capital budgeting, all investment decisions should rely on a rational choice, i.e. choosing among alternatives in a way that accords with the preferences and beliefs of an individual decision maker or those of a group making a joint decision (Doyle, 1998).

Regarding Company X we have no suspicion that this investment decision was irrational, but some indications might touch upon irrationality in regard to the market of electricity certificates. As mentioned in the strategic analysis in section 3, projects initiated after 2021 will not be granted access to these certificates, not to mention that the Norwegian government announced more favorable economic conditions to encourage investors to put their money into the development of new wind turbines (Avner, 2014). The indicated information might certainly influence companies to accelerate their investments before this opportunity is lost forever, which causes investors to disconnect from a rational behavior. If this scenario were to happen it would heighten the supply side significantly and consequently have a negative impact on the electricity certificate market as a whole. Ultimately, every actor in the market loses due to the fact that the green certificate scheme is necessary to yield positive project value. This scenario denotes a type of game theory, which can be defined as the study of conflict and cooperation between intelligent rational decision-makers (Myerson, 1991, p. 1-2). It provides an interesting insight in which various actors make decisions that will influence each other's value creation. Game theory indicates that a company got an incentive to invest early in fear of pre-emption or risk that other companies might eliminate the investment opportunity (Verbeeten, 2006). It is worth noting that Company

X first and foremost is a non-cooperative environment, and therefore not eligible to start alliances- or agreements with other actors to create a win-win situation. This give rise to the known concept of the Nash equilibrium, a fundamental concept in economic theory used to predicting the outcome of strategic interaction, which is irrelevant for the discussion of rationality.

However, there are some interesting findings that points towards that wind farm investments these past years indicate a somewhat irrational investment behavior. That being said, the Norwegian government has proven earlier the willingness to stretch the demand limit for renewable energy production if supply increases rapidly. It is therefore a realistic hope that the relationship between supply- and demand of renewable energy will be controllable, also in the future.

5.6 Comparing Findings with Previous Research

There have been several studies examining the relationship between theoretical- and practical applications to capital budgeting. Hence, it would be interesting to compare our findings with previous conclusions regarding the theory-practice gap.

As presented in section 1, Berg et al. (2013) did a survey with the purpose to shed light on how Norwegian companies perform their analyzes. They found that the NPV-method was preferred over other methods, which is aligned with the findings following from this thesis. Moreover, the survey points to 57 % of the correspondents use sensitivity analysis as a secondary method in capital budgeting and that real options are almost non-existent. These findings are in accordance with our findings, as Company X use NPV as the main method in their capital budgeting and other complementary methods, such as sensitivity analysis of different variables. Company X does not implement real options either. However, the reasons for not implementing real options are not corresponding with the reasons discussed in the survey. As stated in section 4.8, Company X rejects the use of real options, simply because it does not add any additional value to the project, which is perfectly aligned with economic theory. It is not due to the degree of difficulty or lack of knowledge.

Ryan and Ryan (2002) did a survey of capital budgeting decision methods used by the Fortune 1000 companies. The respondents were asked how frequently they use several

different capital budgeting methods such as NPV, IRR and payback method. Their results showed (similar to Berg et al. 2013) that NPV gained the highest positive response in comparison to other basic capital budgeting techniques. The total result showed that NPV and IRR are preferred over all other capital budgeting methods, which is a notable alignment of theory and practice. These findings are further substantiated by a survey done on 300 UK companies (Arnold and Hatzopoulos, 2000).

The three mentioned surveys all correspond to the findings of this thesis in regard to the use of NPV and IRR. In addition, the project manager of Company X revealed that the relationship between NPV and IRR are of greatest importance in the decision-making process.

In academia, it is argued that WACC is the superior base level for cost of capital determinations. Survey respondents were asked which methods in estimating the discount rate they prefer, and WACC was chosen by 83.2 % of the respondents. This substantiates the fact that WACC has a high standing among both practitioners and academia (Ryan and Ryan, 2002).

These results are in accordance with the findings from the analysis of Company X, which support that the theory-practice gap, has been narrowing the last 30 years. Firms with larger capital budgets tends to favor NPV and IRR, and most practitioners prefer to use WACC as the appropriate discount rate. However, the study done in this thesis is not based on a survey containing an extensive questionnaire, but an in-depth analysis of a project initiated by Company X. In this way, the thesis analyzes in detail the assumptions and methods applied by Company X, and study these against a theoretical framework prepared by the thesis. Managers use the NPV method more extensively today, than what was the case 30 years ago, but the studies do not reveal how the DCF information is used and why they make the decisions they do (Arnold and Hatzopoulos, 2000). In this thesis, the latter issues are being tested.

6. Conclusion

Primarily the theoretical approach to this investment analysis yields the same decision as Company X; investing in this specific wind farm project provides a positive NPV. Following the in-depth analysis of the wind farm project initiated by Company X in 2015, the overall objective has been to answer the following:

“Are there significant deviations between how an investment analysis is done in practice, and how the theory states it should be done?”

Based on sophisticated finance- and management accounting literature we were able to answer the research question at hand. Despite our a priori beliefs, findings show that there is a well-established link between how Company X perform their analysis, and how the theoretical framework is designed. This substantiate the fact that the managers of Company X have an inherent understanding in operating advanced analyzes in a correct manner. This leads to the conclusion that *there exist no significant deviations on a superior level*. However, by using a more meticulous scope, we observe some minor deviations regarding assumptions underlying risk and the choice of depreciation method.

First, Company X seems to assess the risk attributable to the project as the firm’s total risk exposure, whereas we find this measure somewhat too excessive. This is not necessarily a breach between theory and practice, but rather a matter of what relevant risk is considered to be. Second, the results from the analysis illustrate deviant objectives in terms of reflecting the true project value. We observe a weak tendency towards making the project as profitable as possible, as opposed to identifying the actual value creation of the project. That being said, using an accelerated depreciation method will always be the superior choice regarding profitability. The mentioned deviations in assumptions and choices are not in breach with theory, but will in fact change the inherent value of the project.

Lastly, the thesis discusses the implementation of real options, and finds no additional value following from these. This is aligned with the conclusion of Company X, that spending time on implementing real options seems unnecessary due to limited flexibility in the project.

7. References

- Abazorius, A. (2015). Patents Forecast Technological Change. *MIT News* [online], 15. April. Available at: <http://news.mit.edu/2015/patents-forecast-technological-change-0415> [Accessed 8 May 2017].
- Ang, A. (2014). *Asset Management*. 1st ed. New York: Oxford University Press.
- Arnold, G. and Hatzopoulos, P. (2000). The Theory-Practice Gap in Capital Budgeting: Evidence from the United Kingdom. *Journal of Business Finance & Accounting*, 27(5), pp. 603-623.
- Avner, T. (2014). Regjeringen blåser nytt håp i norsk vindkraft. *Aftenposten* [online], 04. November. Available at: <http://www.aftenposten.no/norge/Regjeringen-blaser-nytt-hap-i-norsk-vindkraft-69596b.html> [Accessed 18 May 2017].
- Ayres, F. (1994). Perceptions of earnings quality: What managers need to know. *Management Accounting*, 75(9), pp. 27-29.
- Baker, K., Singleton, C. and Veit, T. (2011). *Survey Research in Corporate Finance. Bridging the Gap between Theory and Practice*. 1st ed. Oxford University Press.
- Balakrishnan, R. Sivaramakrishnan, K. and Sunder, S. (2004). A Resource Granularity Framework for Estimating Opportunity Costs. *Accounting Horizons*, 18(3), pp. 197-206.
- Barnett, M. (2008). An Attention-Based View of Real Options Reasoning. *Academy of Management Review*, 33(3), pp. 606-628.
- Benninga, S. (2014). *Financial Modeling*. 4th ed. London: The MIT Press.
- Berg, T. and Westgaard, S. (2012). Risk reporting to the board of directors: Norwegian power companies and banks. *The Journal of Energy Markets*, 5(3), pp. 45-63.
- Berg, T., Østby, L. and Nesse, L. (2013). Bruk av investeringsanalysemetoder og avkastningskrav – Norge anno 2012. *Praktisk Økonomi & Finans*, 29, pp. 87-100.

Berg, T. (2015). Teori vs. Praksis i økonomistyringen- noen betraktninger. *Praktisk Økonomi & Finans*, 3, pp. 219-226.

Bergstrand, J. (2009). *Accounting for Management Control*. 1st ed. Lund: Studentlitteratur AB.

Berk, J. and DeMarzo, P. (2014). *Corporate Finance*. 3rd ed. Harlow, England: Pearson Educational Limited.

Blume, M. (1975). Betas and their Regression Tendencies. *The Journal of Finance*, 30(3), pp. 785-795.

Boudoukh, J., Richardson, M., Smith, T. and Whitelaw, R. (1999). Ex Ante Bond Returns and the Liquidity Preference Hypothesis. *The Journal of Finance*, 54(3), pp. 1153-1167.

Bragelien, I. (2015). *Avkastningskrav og Resultatmåling* [Unpublished script]. Norwegian School of Economics.

Burch, E. and Henry, W.R. (1974). Opportunity and Incremental Cost: Attempt to Define in System Terms: A Comment. pp.118-120.

Bøhren, Ø. (1997). Risk components and the market model: a pedagogical note. *Applied Financial Economics*, 7(3), pp. 307-310.

Company X. (2015). *Årsrapport 2014*. [online]. Company X. Available at: <https://company.x.no/media/pdf/arsrapporter/2014/2014-arsrapport-company.x.pdf> [Accessed 9 Mar. 2017].

Company X. (2016). *Årsrapport 2015*. [online]. Company X. Available at: <https://company.x.no/media/pdf/arsrapporter/2015/2015-arsrapport-company.x.pdf> [Accessed 8 Mar. 2017].

Company X. (2017a). *Om kraftmarkedet*. [online]. Company X. Available at: <https://company.x.no/produksjon/om-kraftmarkedet> [Accessed 28 Feb. 2017].

Company X. (2017b). *Om Company X*. [online]. Company X. Available at: <https://company.x.no/om-company.x> [Accessed 1 Feb. 2017].

-
- Damodaran, A. (n.d.). Equity Risk Premiums (ERP): Determinants, Estimation and Implications- The 2015 Edition. *SSRN electronic Journal*, [online] pp. 3-4. Available at:
<https://poseidon01.ssrn.com/delivery.php?ID=6820250210871251110170030761230791210> [Accessed 9 Mar. 2017].
- Damodaran, A. (2008). *Strategic Risk Taking. A Framework for Risk Management*. 1st ed. Upper Saddle River, N.J.: Wharton School Pub.
- Damodaran, A. (2012). *Investment Valuation. Tools and Techniques for Determining the Value of Any Asset*. 3rd ed. Hoboken, N.J.: Wiley.
- Dowd, K. (1998). *Beyond value at risk*. Chichester: Wiley.
- Doyle, J. (1998). *Rational Decision Making*. [online] The MIT Encyclopedia. Available at:
<https://pdfs.semanticscholar.org/2765/30d33e2dbdfeac8e669130d5400861243996.pdf> [Accessed 10 May 2017].
- Energinorge. (2017). *Elsertifikatordningen gir økt produksjon av fornybar strøm*. [online]. EnergiNorge. Available at:
<https://www.energinorge.no/politiskesaker/elsertifikatordningen/> [Accessed 1 Mar. 2017].
- Fernandez, P. (2007). A General formula for the WACC: A Comment. *International Journal of Business*, 12(3), pp. 400-402.
- Fornybar. (2017a). *Kraftmarkedet- Fornybar.no*. [online]. Fornybar. Available at:
<http://www.fornybar.no/kraftmarkedet> [Accessed 28 Feb. 2017].
- Fornybar. (2017b). *Energipolitikk- Fornybar.no*. [online]. Fornybar. Available at:
<http://www.fornybar.no/energipolitikk> [Accessed 1 Mar. 2017].
- Fornybar. (2017c). *2. Teknologi- Fornybar.no*. [online]. Fornybar. Available at:
<http://www.fornybar.no/vindkraft/teknologi> [Accessed 1 Mar. 2017].

- Graham, J. and Harvey, C. (2001). The theory and practice of corporate finance: evidence from the field. *Journal of Financial Economics*, 60(2-3), pp.187-243.
- Gripsrud, G., Olsson, U. and Silkoset, R. (2010). *Metode og dataanalyse*. 2nd ed. Kristiansand: Høyskoleforlaget AS- Norwegian Academic Press.
- Grytten, O. and Hunnes, A. (2016). *Krakk og Kriser. I et Historisk Perspektiv*. 1st ed. Oslo: Cappelen Damm AS.
- Guermat, C. and Harris, R. (2002). Forecasting value at risk allowing for time variation in the variance and kurtosis of portfolio returns. *International Journal of forecasting*, 18, pp. 409-419.
- Gunther McGrath, R. (1999). Falling Forward: Real Options Reasoning and Entrepreneurial Failure. *Academy of Management Review*, 24(1), pp. 13-30.
- Gunther McGrath, R. and Nerkar, A. (2004). Real options reasoning and a new look at the R&D investment strategies of pharmaceutical firms. *Strategic Management Journal*, 25(1), pp. 1-21.
- Hafslund. (2017a). *Strømforbruk og strømsparing*. [online]. Hafslund. Available at: https://www.hafslund.no/strom/privat/stromforbruk/2025?gclid=CjwKEAjw_PfGBRDW_sutqMbQsmMSJAAMpUapqPrPv_mC0em9QjOK14w_V8ufzuHT2CyTZXu1YZu piBoCCerw_wcB [Accessed 31 Mar. 2017].
- Hafslund. (2017b). *Produksjon*. [online]. Hafslund. Available at: <https://www.hafslund.no/omhafslund/kraftproduksjon/2022> [Accessed 9 Mar. 2017].
- Hafslund. (2017). *4. Kvartalsrapport 2014*. [online]. Hafslund. Available at: https://hafnohafslundno.blob.core.windows.net/files/omhafslund/investor/rapporter/kvartal/2014/Aksjonaerrapport_4_kv_14_NORSK.pdf [Accessed 9 Mar. 2017].
- Hagem, C. and Rosendahl, K.E. (2011). Elsertifikater og Fornybar kraft: Mål eller Middel? *Samfunnsøkonomen*, 3, pp.26-29.
- Harris, R., Stoja, E. and Tucker, J. (2007). A Simplified Approach to Modeling the Co-movements of Asset Returns. *The Journal of Futures Markets*, 27(6), pp. 575-598.

-
- Hastie, R. and Dawes, R. (2010). *Rational choice in an uncertain world*. 1st ed. Los Angeles: SAGE.
- Heskestad, T. (2001). *Regnskapsmessige Avskrivninger: En generalisering av avskrivningsteorien til usikkerhet* [doctoral thesis]. Bergen: Norges Handelshøyskole.
- Hill, R., Griffiths, W. and Lim, G. (2012). *Principles of Econometrics*, 4th ed. New York: Wiley.
- Hope, E. (2011). Vindkraft og vannkraft. *Magma- Econas tidsskrift for økonomi og ledelse*, 2, pp. 57-65.
- Horowitz, J., Loughran, T. and Savin, N. (2000). The disappearing size effect. *Research in Economic*, 54, pp. 84-98.
- Hovland, K. (2017). Utenlandske penger gir nordisk strømboom. *E24* [online], 28. January. Available at: <http://e24.no/energi/fornybar-energi/utenlandske-penger-gir-nordisk-stroemboom/23906427> [Accessed 15 Feb. 2017].
- Jorion, P. (2006). *Value at risk: The new benchmark for managing financial risk*. New York: McGraw-Hill.
- Khindanova, I. (2013). A Monte Carlo Model of a Wind Power Generation Investment. *Journal of Applied Business and Economics*, 15(1), pp. 94-106.
- Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Finance Economics*, 5, pp. 147-175. Referenced in Barnett 2008.
- Markowitz, H. (2008). CAPM Investors Do Not Get Paid for Bearing Risk. *The Journal of Portfolio Management*, 34(2), pp. 91-94.
- Miles, J. and Ezzell, J. (1980). The Weighted Average Cost of Capital, Perfect Capital Markets, and Project Life: A Clarification. *The Journal of Financial and Quantitative analysis*, 15(3), pp. 719-730.
- Mise, E., Kim, T. and Newbold, P. (2005). On suboptimality of the Hodrick-Prescott filter at time series endpoints. *Journal of Macroeconomics*, 27(1), pp. 53-67.

Myerson, R. (1991). *Game Theory: Analysis of Conflict*. Cambridge, MA: Harvard University Press.

Necs.statnett. (2017). *NECS*. [online]. Statnett. Available at: <http://necs.statnett.no/WebPartPages/AveragePricePage.aspx> [Accessed 6 Mar. 2017].

Nordpoolspot. (n.d.). *The Nordic Electricity Exchange and the Nordic Model for a Liberalized Electricity Market*. [online]. Nordpoolspot. Available at: <http://www.nordpoolspot.com/globalassets/download-center/rules-and-regulations/the-nordic-electricity-exchange-and-the-nordic-model-for-a-liberalized-electricity-market.pdf> [Accessed 7 Mar. 2017].

Nordpoolspot. (2017a). *Historical Market Data | Nord Pool*. [online]. Nordpoolspot. Available at: <http://www.nordpoolspot.com/historical-market-data/> [Accessed 15 Feb. 2017].

Nordpoolspot. (2017b). *The power market | Nord Pool*. [online]. Nordpoolspot. Available at: <http://www.nordpoolspot.com/How-does-it-work/> [Accessed 1 Mar. 2017].

Norges-bank. (2017). *Statsobligasjoner månedsgjennomsnitt*. [online]. Norges Bank. Available at: <http://www.norges-bank.no/Statistikk/Rentestatistikk/Statsobligasjoner-Rente-Manedsgjennomsnitt-av-daglige-noteringer/> [Accessed 9 Mar. 2017].

Olje- og Energidepartementet. (2017). *Fornybar energiproduksjon i Norge*. [online]. Regjeringen. Available at: <https://www.regjeringen.no/no/tema/energi/fornybar-energi/fornybar-energi-produksjon-i-norge/id2343462/> [Accessed 1 Mar. 2017].

Pages.stern.nyu.edu. (2017). *Damodaran online: Home Page for Aswath Damodaran*. [online] Available at: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/dataarchived.html#discrete [Accessed 9 Mar. 2017].

Penman, S. (1996). The Articulation of Price-Earnings Ratios and Market-to-Book Ratios and the Evaluation of Growth. *Journal of Accounting Research*, 34(2), pp. 235-259.

Porter, M. (2008). The Five Competitive Forces that shape Strategy. *Harvard Business Review*, 86(1), pp.78-93.

Project Manager. (2017) *Conversation* [unpublished script]. Company X.

Publikasjoner.nve. (2014). *Et norsk-svensk elsertifikatmarked. Årsrapport 2013*. [online]. Norges vassdrag- og energidirektorat. Available at: http://publikasjoner.nve.no/rapport/2014/rapport2014_50.pdf [Accessed 25 Apr. 2017].

PwC. (2014). *The Norwegian Market Risk Premium 2013 and 2014*. [online]. PwC. Available at: <https://www.pwc.no/no/publikasjoner/deals/risikopremieundersokelse-2013-en.pdf> [Accessed 3 Apr. 2017].

Ravn, M. and Uhlig, H. (2002). On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations. *The Review of Economics and Statistics*, 84(2), pp. 371-376.

Ryan, P. and Ryan, G. (2002). Capital budgeting practices of the Fortune 1000: How have things changed? *Journal of Business and Management*, 8(4), pp. 355-362.

Saunders, M., Lewis, P. and Thornhill, A. (2016). *Research methods for business students*. 7th ed. Harlow, England: Prentice Hall.

Savitch, W. (1984). *An Introduction to the Art and Science of Programming*. 1st ed. Menlo Park, California: Benjamin/Cummings Pub. Co.

Statkraft. (2017). *Vindkraft*. [online]. Statkraft. Available at: <http://www.statkraft.no/Energikilder/Vindkraft/> [Accessed 17 Feb. 2017].

Statnett. (2017). *Norge-England – ny mellomlandsforbindelse – Nettutvikling – Statnett*. [online]. Statnett. Available at: <http://www.statnett.no/Nettutvikling/Kabel-til-england/> [Accessed 15 Mar. 2017].

Trigeorgis, L. (1993). The Nature of Option Interactions and the Valuation of Investments with Multiple Real Options. *The Journal of Financial Quantitative Analysis*, 28(1), pp. 1-20.

Trigeorgis, L. (1995). *Real Options in Capital Investment, Models, Strategies and Application*. 1st ed. Westport, Conn.: Praeger.

Trigeorgis, L. (1996). *Real Options: Managerial Flexibility and Strategy in Resource Allocation*. 1st ed. London: MIT Press.

Tu. (2014). *Norges kraftoverskudd forsvinner til England*. [online]. Teknisk Ukeblad. Available at: <https://www.tu.no/artikler/norges-kraftoverskudd-forsvinner-til-england/230246> [Accessed 15 Mar. 2017].

Verbeeten, F. (2006). Do Organizations adopt sophisticated capital budgeting practices to deal with uncertainty in the investment decision?: A Research Note. *Management Accounting Research*, 17(1), pp. 106-120.

Vindportalen. (2017). *Kostnader og investering/økonomi/Vindportalen/hjem-Vindinfo*. [online] Vindportalen. Available at: <http://www.vindportalen.no/Vindportalen/OEkonomi/Kostnader-og-investering> [Accessed 17 Feb. 2017].

Wahlen, J., Jones, J. and Pagach, D. (2012). *Intermediate accounting*. 1st ed. Mason, USA: South-Western Cengage Learning.

Weron, R., Simonsen, I. and Wilman, P. (2004). Modeling highly volatile and seasonal markets: evidence from the Nord Pool electricity market. *The Application of Econophysics*, pp. 182-191.

Weron, R. and Zator, M. (2014). A note on using the Hodrick-Prescott filter in electricity markets. *Energy Economics*, 48, pp. 1-6.

Weron, R. (2014). A review of the state-of-the-art with a look into the future. *International Journal of Forecasting*, 30(4), pp. 1030-1081.

Yahoo! Finance. (2017). *Hafslund ASA (HNA.OL)*. [online]. Yahoo! Finance. Available at: <http://finance.yahoo.com/quote/HNA.OL?p=HNA.OL> [Accessed 9 Mar. 2017].

Yahoo! Finance. (2017). *S&P 500 (^GSPC)*. [online]. Yahoo! Finance. Available at: <http://finance.yahoo.com/quote/^GSPC/?p ^= ^GSPC> [Accessed 9 Mar. 2017].

Yahoo! Finance. (2017). *OSEBX (OSEBX.OL)*. [online]. Yahoo! Finance. Available at: <http://finance.yahoo.com/quote/OSEBX.OL/?p = OSEBX.OL> [Accessed 9 Mar. 2017].

Yang, M. & Blyth, W. (2007). Modeling Investment Risks and Uncertainties with Real Options Approach. *International Energy Agency Working Paper Series*, Paper number LTO/2007/WP01.

Zangwill, W. and Kantor, P. (1998). Toward a Theory of Continuous Improvement and the Learning Curve. *Management Science*, 44(7), pp. 910-920.

APPENDIX 1:

1.1 Questionnaire to the Project Manager

- 1) Hva slag metode brukes for å analysere verdien av prosjektet?
- 2) Betales det ekstra skatt på vindkraft?
- 3) Hva er levetiden/horisont på prosjektet? Er levetid på turbin og prosjekt sammenstilt? Hvis ikke, ligger det til grunn reinvesteringer gjennom prosjektets levetid? Når er oppstart for prosjektet?
 - Hvor mange turbiner eksisterer i vindparken?
 - Hvilken effekt har disse?
- 4) Hvordan beregner dere fremtidige strømpriser? Estimeringsmodeller, simulering eller bygger dette på erfaring? I tillegg benyttes eventuelle antakelser om usikkerhet og scenariobygging?
- 5) Priser er ikke påvirket av konkurranse intensiteten i bransjen, kun av tilbud og etterspørsel?
- 6) Hvor mange timer i året produserer turbinen i snitt? Vil turbinen klare å produsere på maks kapasitet gjennom hele levetiden?
- 7) Hvor mye volum (MW) produseres i året? Hvordan estimeres volumprognoser fremover i tid? Det stemmer at alt som produseres blir solgt? Er det vinden som fastsetter volum, og derav hvor mye dere selger?
- 8) Produserer dere konsesjonskraft?
- 9) Hvordan fungerer konsesjonsrettighetene? Hvordan er disse bygd opp, og hva inneholder dem? Eksisterer det kostnad for disse?
- 10) Hvordan estimeres elsertifikatpriser? Hvordan fungerer dette markedet?
- 11) Driftskostnader:
 - Hva består driftskostnadene av? Variable og faste? Estimeres tap i produksjon?
 - Er de faste kostnadene reversible?

-
- Hvor store er disse kostnadene?
 - Hvilken skattesats benyttes?
- 12) Investeringskostnader:
- Hvor stor er investeringskostnaden?
 - Består denne av forskjellige deler?
 - Hvilken avskrivningsmetode bruker dere?
- 13) Hvordan estimerer dere avkastningskravet? Hva er størrelsen på dette?
- 14) Hvilke tall vektlegges mest fra analysen? NPV eller IRR, eller en kombinasjon?
- 15) Benyttes realopsjoner? Eksempelvis videresalg etter levetid, exit, ekspandere eller utsette investering i påvente av prisendring i markedet.
- 16) Er det muligheter for reinvesteringer av turbiner i vindparken hvis det stedet viser seg å produsere mye vind?
- 17) Måler dere sensitivitet på variabler som inngår i analysen?
- 18) Er alt av rentebærende gjeld obligasjoner? Er ca. 4% et for høyt estimat på lånerenten deres på tidspunktet investeringsbeslutningen ble tatt?
- 19) Hvordan er gangen fra investering til beslutning tas? Er det en spesifikk avdeling som gjør dette eller skal prosjekteringen gjennom en type samlebånd?
- 20) Er volum og pris eneste usikkerhetsfaktor for fremtidig inntekstvekst? Er fornybar energi et konkurransefortrinn?
- 21) Hvordan er prosjekteringen fra A til Å kort fortalt. Hvem gjør hva?
- 22) Ettersom vindkraftbransjen er kapitalintensiv, fører det til høye inngangsbarrierer/utgangsbarrierer i bransjen?
- 23) Eksisterer det leverandørmakt av vindturbiner, og installasjon av disse? kan leverandørene prise dette som de vil? Vi regner med liten kundemakt da det handles på børs?

APPENDIX 2:

2.1 Extended Theory on Real Options

Real options theory concerns classes of investments in real assets that are like financial options in structure. If investments are staged so that expenditures end under poor conditions, these losses can be contained. Strategy scholars realized how relevant this conceptual framing was for decision making under uncertainty. They began researching how firms may use small initial investments to gain the strategic flexibility to defer decisions, to fully commit to costly projects until uncertainty is better resolved (Barnett, 2008).

Traditional project evaluation techniques have not recognized the value of managerial intervention in containing downside losses. By not recognizing this aspect of the project, have led firms to reject risky projects that otherwise would have huge upside potential (Barnett, 2008). An option creates value by generating future decision rights. The theory of real options, in which the option in question is a real asset, is derived from finance theory. A firm that invest in R&D can create a unit of new knowledge, it can commercialize this knowledge through patenting. Subsequently the firm has several options, it can elect to proceed to extend the knowledge, commercialize it, to do nothing with it, share it with a joint venture or licensing it out. Investing in real options allow firms access to more opportunities than would be possible if each investment represented a full-scale launch (McGrath and Nerkar, 2004).

Most firms realize that they face uncertainties about the future, yet firm's strategic investment decisions are primarily based on a single estimate of future events. However, most managers are aware of the failure to consider the uncertainty can lead to costly errors. The difficulty of such planning leads many to ignore these possible costs and hope that such problems not will incur (Trigeorgis, 1995, p. 31-32).

In a real option framework, we are ignoring the time-honored rules of capital budgeting, which includes rejecting projects with negative NPV, when real options are present. Furthermore, not only does the real options approach encourage managers to make investments that do not meet financial criteria, but it also makes it more likely that they will do so. To prevent real options approach from being used by managers who want to

rationalize bad and risky decisions, we must impose constraints on when- and how it can be used. Option pricing models are based on two fundamental aspects, replication and arbitrage. For either to be feasible, it must be possible to trade on the underlying asset on the option. This is easy with a listed option on a traded stock, however, it is much more difficult to do when valuing a patent or an investment expansion opportunity (Damodaran, 2008, p. 257-259).

The literature on real options to date has been focused on valuing individual options. However, flexibility embedded in investment projects by management typically takes form of a collection of real options. The combined value of operating options can have a large impact on the project value, while the incremental value of an additional option tends to be lower the greater the number of already present options. Management's collection of options, introduces an asymmetry or skewness in the probability distribution of NPV. This expands the opportunity's true value relative to passive NPV by improving its profit potential, while at the same time limiting the losses.

Traditional valuation approaches that either ignore these options or attempt to value the investment opportunities using a constant discount rate, can lead to errors in the valuations. This follows by the asymmetric claims on an asset do not have the same discount rate as the asset itself. This can properly be analyzed by viewing flexibility in an options framework (Trigeorgis, 1993). This approach to valuing a project using a collection of options, is equivalent in some way to valuing an exotic financial option. For instance, one can have options within an option. The valuation of options in practice has greatly increased after Cox and Ross (1976) recognized that an option can be replicated from an equivalent portfolio of traded stocks. They referred to this as a synthetic option. Such risk-neutral valuations enable present value discounting, using the risk-free rate of expected future pay-offs. This is a fundamental characteristic of "arbitrage-free" price system involving traded assets. Trigeorgis and others, maintain that real options may be valued like financial options, even though they may not be traded. The argument is that in capital budgeting one wants to determine what the value of future cash flows would be if they were traded in the market (Trigeorgis, 1996, p. 16-17). More generally, several researchers have suggested that any contingent claim on an asset, traded or not, can be priced in a world containing systematic risk. This by replacing its expected cash flow with a certainty equivalent, and behave as the world was risk neutral (Trigeorgis, 1996, p. 17).

2.2 Extended Theory on Opportunity Cost of Capital

Both the returns from the CAPM and from the WACC are used to discount the estimated cash flows from a project. Nonetheless, the CAPM discounts the equity cash flow, whereas the WACC discounts the cash flow to the firm. These discount rates are referred to as the investor's opportunity cost of capital, which in the finance literature is defined as (Berk and DeMarzo, 2014, p 159):

“The best available expected return offered in the market on an investment of comparable risk and term to the cash flow being discounted”

The accounting literature also makes use of the term, opportunity cost. There are some ambiguities in management accounting on how to define the term. However, Burch and Henry have provided a definition which seems to be unambiguously. They define the opportunity cost as (Burch and Henry, 1974):

“Opportunity cost is the sacrifice involved when a limiting resource or a bundle of limiting resources required by the alternative under consideration is taken from its next best use”.

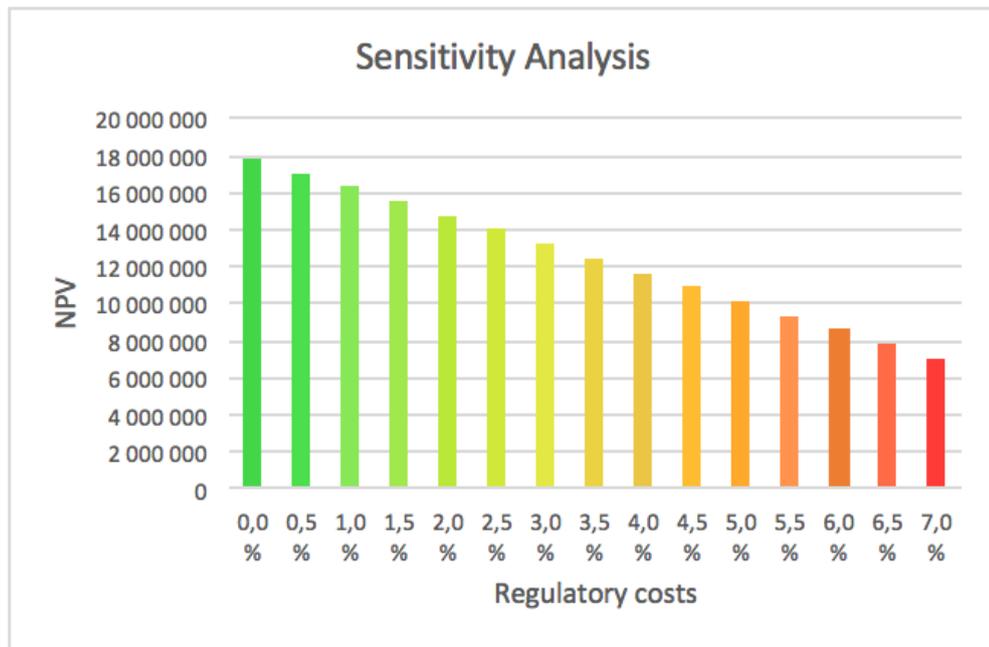
The next best can be referred to another use of capital inside the firm, or it may be an investment in another project. Opportunity cost requires the measurement of sacrifices, if there are no sacrifices in the decision, then the decision is cost free (Burch and Henry, 1974).

The cost of capital is clearly relevant for a firm seeking to raise capital from outside investors, or when investing money into a project. The cost of capital represents the best return the company can get from the next best alternative, and the project should *only* be accepted if it offers better returns than other opportunities (Berk and DeMarzo, 2014, p 159). This can be formulated as:

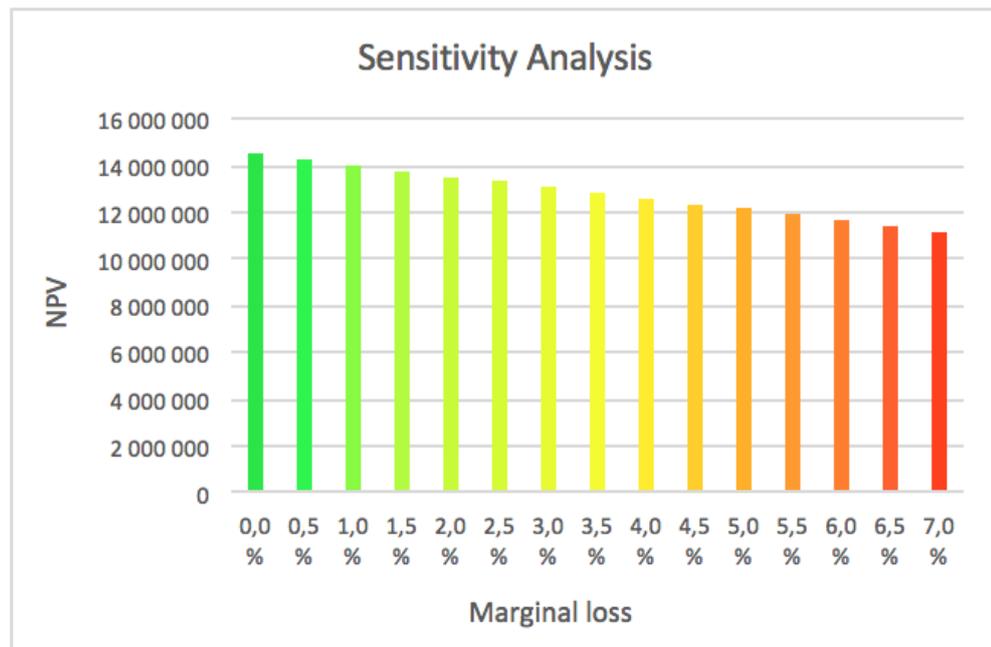
$WACC < IRR$ (Internal rate of return), or $NPV > 0$.

APPENDIX 3:

3.1 Complementary Sensitivity Inputs



Measures the sensitivity of regulatory costs and the effect on the project's net present value



Measures the sensitivity of marginal loss rates and the effect on the project's net present value