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TITLE:

Oil & Gas Investments: Valuation Analysis of Aker BP ASA - Valhall IP Upgrade

Author(s)		FACULTY SUPERVISOR:
Candidate number:	Name:	Kjell Jørgensen
237281 …………………	Christian Lyse ……………………………………………………………	EXTERNAL SUPERVISOR:
…………………	……………………………………………………………	Lars Olav Lien – Aker BP ASA

ABSTRACT

This master thesis conducts a valuation of Aker BP's upgrade of the Valhall water injection platform (IP). The upgrade involves replacing outdated drill floor equipment with state-of-the art robot technology. Studies performed by the contractor in cooperation with Aker BP indicated major costs savings and increased drilling performance with the new system. For this purpose, the primary valuation method, a DCF model, concludes that investing in the Valhall IP upgrade has a significant upside compared with current conventional drilling methods.

The thesis begins with the valuation framework by reviewing relevant theoretical approaches. It then addresses the oil and gas industry and the history and current state of Aker BP, Canrig Robotic Technologies, and Valhall IP. Following that, it engages in a strategic SWOT-analysis to provide an overview of the project, and moves on to a valuation analysis, which constitutes the main portion of this thesis. The valuation analysis consists of calculating the cost of equity, DCF, and the projects initial payback period.

Given the results from the valuation analysis and the DCF model, the recommendation is to invest in the Valhall IP upgrade, since the net present value is positive and increases the wealth of Aker BP and its investors.

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PREFACE

This thesis represents the final work of the 3-year Executive Masters in Business Administration program (EMBA) at the University of Stavanger.

I would like to use this opportunity to thank several people who have helped me in the work of this thesis. I would first like to express my appreciation to the Valhall IP team in Aker BP for allowing me to take on this assignment as well as the material and intellectual support that they have contributed to this process.

My deepest gratitude goes to the Drilling Engineering Manager and my Aker BP mentor Lars Olav Lien who has supported, educated, and facilitated me in my work to complete this thesis. I would also like to thank Valhall IP Project/Drilling Engineer Christer Brown, Philip Cederholm, Martin Elseth and Bjarne Haaland for their great guidance and support.

I would also like to express my gratitude to my advisor at the University of Stavanger, Kjell Joergensen. His valuable insight and genuine interest in the topic of this thesis have been major motivational factors throughout the process.

Finally, a special thanks to my family and loved ones for support and for making it possible for me to complete the EMBA program.

"Float like a butterfly sting like a bee – his hands can't hit what his eyes can't see"

Muhammad Ali, 1974

Stavanger, May 21st 2019

Christian Lyse

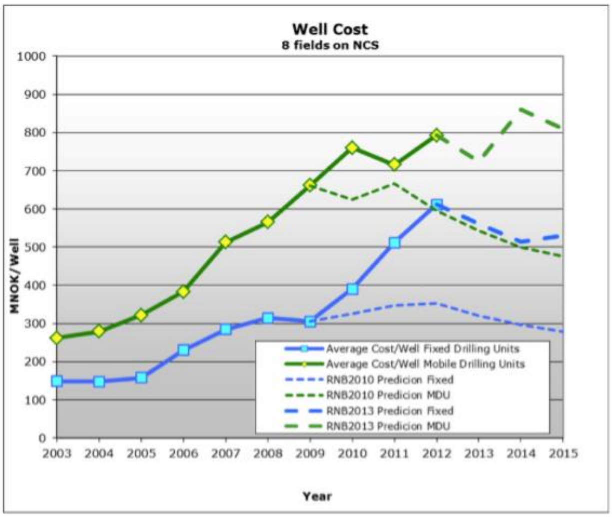
CHAPTER 1: INTRODUCTION

This chapter introduces the background for the selected problem statement. It presents the information sources used, and an overview of the composition of the thesis.

1.1 Background

For years, the oil and gas industry has been dependant on heavy mechanical machinery operated by rig staff to find natural resources. However, this is about to change with the help of the latest innovative technology in automated drilling systems. Automation of various aspects of the drilling process requires a comprehensive understanding of the interactions between fluid and mud properties, pipe handling, precise borehole-pressure control and different drilling operations such as tripping, directional drilling and pump startup (Øyvind Breyholtz, 2012). In addition, increasing the level of automation in the drilling process can help operators to achieve faster and more predictive well construction.

Figure 1: Average well cost *Source: Petoro, 2014*



Petoro (2014) estimates that the average cost of drilling a well by a fixed installation and a mobile rig has more than doubled in the period 2006 – 2012. According to Norsk Petroleum (2019), the high level of investments and exploration activity, combined with high operating costs, resulted in record overall costs on the Norwegian continental shelf in 2014. Moreover, rising crude oil inventories and expected increases in shale production led to oversupply and the oil price collapsed from a high of $114 per barrel in June 2014, to less than $30 dollars per barrel in the early months of 2016 (Bolton, 2019). The oil and gas industry entered into a downturn resulting in massive layoffs, rigs going offline and increased market volatility. A few years later, the oil and gas industry continued its slow recovery with increasing oil demand and higher oil prices.

One of the companies that repositioned themselves during the oil and gas downturn was Det Norske Oljeselskap ASA. In 2016, Det Norske Oljeselskap ASA merged with British Petroleum's Norwegian business and established oil and gas giant Aker BP ASA, becoming the largest Norwegian independent oil and gas producer. The merger significantly strengthened the combined companies operations, cost efficiency, and growth potential. During 2018, Aker BP progressed studies of introducing robotic drill floor equipment as a retrofit onto the Valhall IP fixed platform in the North Sea. Studies indicated a large potential of savings in rig downtime and possible elimination of manual operations on the drill floor when robotic equipment is introduced.

1.2 Purpose

The main purpose of this thesis is to value Aker BP's investment in robotic drilling systems on the Valhall IP platform. It investigates the general expectations towards Aker BP's vision to digitalise the entire life cycle for operations, and whether the industry fully understands what that means. While the company's goals can seem ambiguous, there is a real need for change and innovation, to solve the industry's challenges. The research question for this thesis is thereby formulated as follows:

What is the fair value of Aker BP ASA - Valhall IP Upgrade?

The investment will be analysed based on different valuation approaches to create a quantitative view of the proposed asset investment. Combined with a strategic analysis of Aker BP and the Valhall IP upgrade, the analysed elements will create a basis to objectively asses the assets value. In addition, relevant macroeconomic and microeconomic forces, theoretical perspectives, and frameworks are included in the business environment.

1.3 Limitations

This thesis conducts a valuation analysis of the Valhall IP upgrade. The main limitation to the research is the Discounted Cash Flow (DCF) valuation analysis. This is due to the limited information available to perform the valuation. However, in partnership with Aker BP, the limitations are accounted for by using best estimates in the calculation.

1.4 Thesis Structure

Based on the choice of company and problem statement, this thesis continues with the following chapters:

Chapter 1: Introduction

Introduces the thesis's background and main purpose. The limitations of the thesis's limitations are discussed at its end.

Chapter 2: Valuation Framework

Presents the theories needed in the valuation analysis. It starts with investment decision making and cash flow statements before introducing the main valuation approaches. It continues with the cost of equity and its corresponding definitions of the Capital Asset Pricing Model (CAPM) sections.

Chapter 3: The Oil and Gas Industry

Opens with a short introduction of the oil and gas industry and continues with a presentation of the global energy demand and oil and gas supply. It then presents an introduction to the Norwegian oil and gas supply. Finally, this chapter provides an overview of the formation of oil prices.

Chapter 4: Aker BP ASA

Presents the background of Aker BP and its vision and values.

Chapter 5: Canrig Robotic Technologies AS and Valhall IP Upgrade

Presents the background of Canrig Robotic Technologies AS (Canrig) and its robotic drilling system technology, including a technical description of the main components and required personnel support.

Chapter 6: Strategic Analysis

Introduces the framework for strategic analysis and essentially conducts a SWOT analysis of the Valhall IP upgrade.

Chapter 7: Valuation of Valhall IP Upgrade

Contains the calculations of CAPM, DCF and the payback method.

Chapter 8: Summary, Conclusion and Recommendations

Provides the study's summary, conclusions and recommendations.

CHAPTER 2: VALUATION FRAMEWORK

The purpose of this chapter is to provide an overview of the valuation framework, which will be used when estimating a fair value of the Valhall IP upgrade. It provides the reader with principles and concepts of investment decision-making, and the theoretical framework for valuation approaches. It also introduces the theory behind the cost of equity, which is estimated in the chapter on valuation analysis.

2.1 Investment Decision-Making

The importance of investment decisions in business is evident, since the decisions and the need to adapt financial strategies contribute to the firm's success or failure. Decision-makers can benefit from having implemented a financial strategy specifically designed to improve and optimise corporate results. The financial strategy represents a path and can include elements such as investments, costs, funding and working capital. The combination of these elements combined in an optimum financial strategy can increase firm value, by providing benefits with greater value than costs, and create a greater prospect for future opportunities. Identifying and qualifying the factors that contribute to failure in the value chain are important, as doing so provides the basis of investment decision-making. This chapter introduces a central principle of finance, the valuation principle, which states that current market prices can be used to determine the presents value of the costs and benefits associated with a decision (Berk & De Marzo, 2017, p.93). This information will determine if the investment decision will maintain business competitiveness, optimise present and future earnings, and position the firm as an organisation that adds value to its shareholders in the form of dividends.

Investments typically involve the commitment of capital for a certain duration, in exchange for future payments that would compensate stakeholders. It involves "the time value of money", which is the difference in value between money available at the present time and money in the future arising from its potential earning capacity. The rate at which money can be exchanged is determined by the interest rate, which indicates the present market price of money in the future. The risk-free interest rate is the rate of return of an investment with zero risk. In practise, the risk-free interest rate is the minimum return an investor expects for any investment.

This thesis focuses on Aker BP's investment project in automated drilling systems on Valhall IP. The technology has the potential to create considerable value and save investment costs through improved drilling efficiency. In conventional drilling methods, costs are primarily a function of high day rates for rigs, third party services, and the time used to drill a well. The cost drivers are mainly driven by the market and the fact that rig equipment are industry specific makes them more exposed to risk and future maintenance costs. In addition, because of the challenges of more complicated reservoirs (deeper fields, longer wells, higher-pressure and higher-temperatures) operators are starting to see the benefits of automation from a safety perspective. Nevertheless, as short-term and long-term market conditions evolve, investment decision-making to maintain business competitiveness has become more important and more challenging.

As mentioned previously, the valuation principle provides the basis for investment decision-making as costs and benefits can be converted to the same point in time. Thus, when making investments decisions, most firms and investors are interested in the present value of the investment that is the value of the investment in terms of cash at the present time. The concept captures the idea that money today is more valuable than money in the future. If money is received 01.01.2019, this can immediately go to consumption. Alternatively, money can be invested and provide future income. If instead money is received 01.01.2020, inflation will reduce the purchasing power. Given this methodology, valuation of assets, becomes possible and straightforward.

2.2 The Statement of Cash Flows

The statement of cash flow is the difference between a firm's cash inflows and outflows in the same time period. The statement of cash flows is divided into three main activities: operating activities, investment activities and financing activities.

- Operating activities: Revenue producing activities typically associated with sales, purchases, and other expenses. Over time, positive cash flow from operating activities, indicate that the firm has positive operating profits. If positive profits and negative cash flows from operations occur, such deviation may be a result of inventory building up or cash has not been received from customers.

- Investment activities: The cash required for investments (acquisitions minus disposals) in operating assets. These purchases are referred to as capital expenditures and are recognised over time as depreciation expenses.
- Financing activities: Activities that result in changes to the inflow and outflow of cash. Financing cash flows are typically associated with net borrowings, repayment of debts, issue or repurchase of firm stock, and dividends payments.

The statement of cash flows is useful to investors as it provides an overall picture of the firm's cash inflows and outflows. The statement also provides valuable information about future cash flows and can help to determine if the firm needs to raise capital to remain in business.

2.3 Valuation Approaches

The central focus in fundamental analysis is a valuation. It is the process by which firms analyse alternative investment opportunities and decide which ones to accept or reject. The goal is to assess the projects lifetime cash inflows and outflows, in order to determine the investments effect, and whether its potential returns, meet the firm's target benchmark. Any valuation approach can provide a relatively accurate value of an investment, but the key is to use a valuation approach that captures the aspects of the best alternative investment that generates value.

"The value of an asset to the firm or its investors is determined by its competitive market price. The benefits and costs of a decision should be evaluated using these market prices, and when the value of the benefit exceeds the value of the costs, the decision will increase the market value of the firm" (Berk & De Marzo, 2017, p.96).

2.3.1 Present Value (PV)

The present value is the current value of cash discounted to future cash flows or incomes. The method allows future cash flows to be discounted at a specified discount rate. The higher the discount rate, the lower the present value of the future cash flows. This corresponds to the time value of money concept explained in chapter 2.1.

Equation 1: Present value

$$Present\ Value = \frac{FV}{(1+r)^n}$$

Source: Berk & DeMarzo, 2017

Where,

FV = Future value

r = Rate of return

n = Number of periods

2.3.2 Discounted Cash Flow

The DCF method is the foundation on which all other valuation approaches are built on. Its foundation is the present value, where the value of any asset is the present value of expected future cash flows from it (Damodaran, 2012). Due to the variation of cash flows from asset to asset, the discount rate acts as a risk function towards the estimated cash flows. Hence, the purpose of the discounted cash flow method is to estimate the intrinsic value of an asset by reviewing its fundamentals.

There are two approaches to the DCF method: The first approach is to value the asset equity, while the second is to value the entire firm. In this thesis, the valuation of Valhall IP upgrade is based on the following equation:

Equation 2: Discounted cash flow

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \cdots + \frac{CF_n}{(1+r)^n}$$

Source: Berk & DeMarzo, 2017

Where,

CF = Cash Flow

r = Discount rate

n = Number of periods

2.3.3 Net Present Value

The net present value (NPV) is the difference between the present values of an assets benefits and its costs. In general, an investment with positive cash flow reflects its benefits, and a negative cash flow reflects its costs. The assumption is that investments with positive NPVs are profitable and investments with negative NPVs are loss-making. Hence, the NPV is the sum of the present value of all cash flows.

Equation 3: Net present value

$$NPV = PV\ (Benefits) - PV\ (Costs)$$

Source: Berk & DeMarzo, 2017

The NPV Decision Rule

An investment project generates a series of cash flows at different points in time. However, due to the range of discount rates and the potential of earnings from alternative investments, money in the present is worth more than the same amount in the future. The following equation illustrates the NPV with multiple cash flows:

Equation 4: Net present value with multiple cash flows

$$NPV = -I + \sum_{n=1}^{\infty} \frac{CF}{(1+r)^n}$$

Source: Berk & DeMarzo, 2017

Where,

I = Initial Investment

CF = Cash flow

r = Discount rate

n = Number of periods

The NPV yields absolute values, dependent on the initial investment (I) and subsequent cash flows (CF) discounted by the expected rate of return (r).

The NPV decision rule can be stated as follows:

"When making an investment decision, take the alternative with the highest NPV. Choosing this alternative is equivalent to receiving its NPV in cash today" (Berk & De Marzo, 2017, p.101).

This logic simplifies decision-making and implies that management should accept projects with positive NPV and reject projects with negative NPV. If the NPV is zero, the project does not increase or reduce the wealth of the company and its investors.

2.3.4 Internal Rate of Return

The internal rate of return (IRR) is used to estimate the profitability of investments and is defined as the discount rate that sets the cash flows NPV to zero. Depending on the context of use, it is also called the rate of return (ROR) or effective interest rate. The IRR provides information about the projects sensitivity to the NPVs estimate of its cost of capital. In theory, any project with an IRR more than the cost of capital is profitable and therefore, the decision to proceed with the project is correct. If the IRR is less than the cost of capital, the NPV is negative and the decision to reject the project is correct.

Equation 5: Internal rate of return

$$0 = NPV = \sum_{n=0}^{N} \frac{CF_t}{(1 + IRR)^n}$$

Source: Berk & DeMarzo, 2017

The IRR is symmetrical to the standard NPV formula. However, the discount rate that sets the NPV to zero is in turn the IRR. According to Corelli (2018), only numerical or graphical methods can determine the IRR value which discard the analytically method to find the IRR value.

The IRR Rule

The IRR investment rule can be stated as follows:

"Take any investment opportunity where the IRR exceeds the opportunity cost of capital. Turn down any opportunity whose IRR is less than the opportunity cost of capital" (Berk & De Marzo, 2017, p.248).

In general, the higher the IRR and the greater the return on cost of capital, the higher the net cash flow generated by the project or investment. Just like the NPV rule, the IRR rule is a guideline applied to single, stand-alone projects. According to Corelli 2018, the IRR is an indicator of an investments efficiency, quality, and yield as opposed to the NPV, which refers to the investments value and magnitude of an investment.

As with most models, IRR has some drawbacks, which in turn can lead to incorrect investment decisions. Situations where the IRR rule fails are presented below.

The first situation where the IRR rule fails is where there is a delay in investment, that is, when investments benefits occur before its costs. In this case, the IRR and the NPV rule will give opposing recommendations. This is because when there is a delay in investment, the cash flow is interpreted as borrowing money, and a rate lower than the cost of capital is preferred. Even though the NPV method should be applied when calculating delayed investments, the IRR rule still provides useful information about the investment sensitivity and uncertainty in the cost of capital estimate.

The second situation where the IRR rule fails is when multiple IRRs can set the NPV to zero, or the IRRs are non-existent. Multiple IRR cash flow values can either be negative or positive within the investment project period. When no IRR exists, the IRR rule provides no guidance whatsoever since the NPV is positive for all discount rates. When there are multiple IRRs or no IRRs, the only choice is to rely on the NPV rule.

The limitation of using the IRR rule for investment decisions is that IRR measures the average return of an investment and indicates the NPVs sensitivity to the cost of capital. Thus, IRR itself remains a useful tool, but relying on it alone can be hazardous when making investment decisions. If the management's logic is to maximise its wealth, it should use NPV when undertaking a project.

2.3.5 Payback Method

The payback method is an alternative approach that applies to single, stand-alone projects within the company. By looking at the projects annual cash inflows within a predetermined time period, the time required to recover the cost of the investment can be calculated. The payback method is useful because the project can be accepted if the payback period (P_p) is less than the predetermined time period, otherwise it can be rejected. The practice is to have the average payback period length ($\tilde{P}_p$) around three years. Projects should be accepted if $P_p < \tilde{P}_p$, and rejected if $P_p > \tilde{P}_p$. If $P_p = \tilde{P}_p$, then the company can be indifferent.

The payback method is simple and easy to use, and provides a measure of the money at risk for the project. However, compared to the NPV, it ignores the cost of capital and the time value of money. Furthermore, the payback method does not account for cash flows after the payback period. Hence, this method is typically most useful in decisions regarding smaller investments where the cost of making an incorrect decision might not be as crucial.

Despite the simplicity of the payback method, Graham and Harvey's (2001), survey on the way firms evaluate projects suggests that of 392 American CFOs, over 50% use the payback method as a capital budgeting technique. The likelihood that a company will use specific methods is linked to firm size, firm leverage, and the CEOs characteristics.

In March 2018, Canrig executed a preliminary pre-study report in cooperation with Aker BP. The report contained calculations about the investment project by using the payback method. The calculations will be presented in Chapter 7.3, which describes the payback method for the Valhall IP upgrade.

2.4 Cost of Equity

Cost of equity is the rate of return investors should require for investing capital on a project. The return typically reflects the risk-free interest rate, plus an appropriate risk premium to make the investment worthwhile. This rate of return is required to value Aker BP's upgrade of Valhall IP by using the DCF model.

2.4.1 Systematic Risk and CAPM

Systematic risk is the risk that cannot be eliminated through diversification, as it affects the overall market and not just a particular stock or industry. Unlike unsystematic risk, systematic risk is unpredictable and consists of the day-to-day fluctuations in a share price. Unsystematic risk, also known as "specific risk" or "diversifiable risk", will not be further discussed in this thesis because it can be eliminated through diversification into different sectors, which balances the markets effects. For any project or investment opportunity, the investor wants higher earnings in return, as compensation for taking on systematic risk. This additional return is the investors expected risk premium and is determined by measuring the systematic risk. Another important factor driving higher premiums is the investors risk attitude. A risk-averse investor prefers lower returns with known risks over higher returns with unknown risks. To measure the systematic risk of a stock, one must determine how much of the variability of its return is due to systematic, market-wide risks, as opposed to diversifiable, firm-specific risks (Berk & De Marzo, 2017, p.375). In this case, calculating the sensitivity to systematic risk is complete by the introduction of the beta value β. The beta indicates whether the investment is more or less volatile compared to market conditions.

"The beta of a security is the expected percentage change in its return given a 1% change in the return of the market portfolio" (Berk & De Marzo, 2017, p.375).

More specifically, the risk measured by beta is not diversifiable. It does not measure the risk of an investment held on a stand-alone basis, but the amount of risk the investment adds to an already diversified portfolio (Corelli, 2018). Knowing the market risk and the risk premium provides the opportunity to estimate the cost of capital for an investment project. The most used method is the Capital Asset Pricing Model (CAPM), which estimates the investor's required return based on the projects risk.

Equation 6: Capital asset pricing model

$$E[R_i] = r_i = r_f + \beta_i \times (E[R_m] - r_f)$$

Source: Berk & DeMarzo, 2017

Where,

$E[R_i]$ = Expected return of investment

r_f = Risk-free interest rate

β_i = Beta of the investment

ER_m = Expected return of market

$(ER_m - r_f)$ = Market risk premium

The CAPM takes into account the investors expected compensation (risk premium), represented by the difference between the market portfolios expected return and the risk-free interest rate. Thus, in a competitive market, the expected return from investments should be similar when identical or equal risk is involved. For Aker BP, the discount rate used for fair value testing was 10% (Aker BP, 2018). In this study, the cost of capital was calculated with the traditional CAPM method. Based on levered beta, the equation to use is as follows:

Equation 7: Return on equity

$$r_e = r_f + \beta_L \times (r_m - r_f)$$

Source: Berk & DeMarzo, 2017

Where,

r_e = Return on equity

r_f = Risk-free interest rate

β_L = Levered beta

$(r_m - r_f)$ = Market risk premium

2.4.2 Risk-Free Rate

The risk-free rate is the rate an investor can expect from investing in a risk-free asset over a specific time-period. A typical example of a risk free asset is the yields on annual Treasury bonds. A risk-free rate used for further calculations is based on the Norwegian Governments bonds with a 10-year duration. In 2018, the yield of a 10-year Norwegian Treasury bond was 1.88% (Norges Bank, 2019). Since the Valhall IP upgrade is considered to be a long-term investment project, using the 10-year Treasury bonds as a reference seemed fair.

2.4.3 Beta Estimation

As mentioned in section 2.4.1, beta measures the systematic risk of the return on a security, compared to the overall market portfolio. One way of estimating the beta is the regression method. This method either calculates a comparable public firm's average equity and adjusts it for differences in the financial structure, or regresses the historical returns of a market portfolio. In this case, the two approaches to estimating the beta for Aker BP seemed reasonable. The first approach used the beta found on the E24 stock exchange, while the second approach expressed the estimated beta with the following equation:

Equation 8: Levered beta

$$\beta_L = \beta_U + \frac{D}{E}(\beta_U - \beta_D)$$

Source: Berk & DeMarzo, 2017

Where,

β_L = Beta of equity

β_U = Unlevered beta

β_D = Beta of debt

$\frac{D}{E}$ = Market value of debt

In this study, Damodaran's (2019) unlevered beta of 1,03 is used to calculate Aker BP's beta of equity. Since the unlevered beta is a comparison of 301 oil and gas companies from the exploration and production sectors, it would seem reasonable to use the beta for this purpose. In June 2017 and March 2018, Aker BP received a BB+ credit ranking from the US-based company Standard & Poor (S&P), and a rating of Ba1 from Moody's (Aker BP, 2019). The ratings expressed the companies' opinions on Aker BP's willingness and ability to meet its financial obligations in full, and on time. The BB+/Ba1 rating symbolises a speculative grade, which implies that Aker BP has the ability to repay its debt obligations, but faces uncertainties that could affect credit risk. This credit rating is used in combination with Pratt and Grabowski's (2014) research, which suggests that betas of debt generally correlate with credit ratings. Table 1 shows the relationship between credit ratings and the estimated beta of debt in a 3.5 years' time period, which was generated by Moody's.

<u>Table 1:</u> Estimated beta of debt based on credit ratings

Moody's Rating	2010											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aaa	0.22	0.22	0.21	0.21	0.19	0.16	0.17	0.14	0.13	0.11	0.11	0.10
Aa	0.24	0.25	0.24	0.25	0.24	0.21	0.22	0.20	0.19	0.18	0.18	0.17
A	0.36	0.36	0.35	0.35	0.34	0.32	0.32	0.31	0.29	0.28	0.28	0.27
Baa	0.41	0.41	0.39	0.40	0.39	0.37	0.38	0.37	0.35	0.34	0.34	0.33
Ba	0.59	0.58	0.58	0.58	0.58	0.57	0.57	0.56	0.55	0.55	0.56	0.54
B	0.67	0.66	0.65	0.65	0.65	0.64	0.64	0.63	0.63	0.64	0.64	0.62
Caa	1.00	0.99	0.98	0.98	0.98	0.95	0.95	0.94	0.91	0.90	0.91	0.89
Ca-D	1.57	1.56	1.54	1.53	1.52	1.49	1.46	1.45	1.39	1.38	1.39	1.37
Moody's Rating	2011											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aaa	0.10	0.10	0.11	0.11	0.11	0.11	0.10	0.08	0.04	0.03	0.03	0.04
Aa	0.17	0.17	0.17	0.18	0.17	0.18	0.17	0.16	0.14	0.14	0.14	0.14
A	0.27	0.27	0.27	0.28	0.27	0.27	0.27	0.26	0.23	0.23	0.23	0.23
Baa	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.32	0.31	0.31	0.31	0.31
Ba	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.52	0.52	0.52
B	0.63	0.62	0.62	0.62	0.63	0.63	0.62	0.63	0.64	0.65	0.65	0.65
Caa	0.89	0.89	0.89	0.89	0.90	0.90	0.90	0.91	0.92	0.93	0.93	0.93
Ca-D	1.37	1.37	1.37	1.36	1.37	1.38	1.38	1.41	1.43	1.42	1.42	1.42
Moody's Rating	2012											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aaa	0.04	0.04	0.03	0.03	0.02	0.01	0.02	0.02	0.01	0.01	0.02	0.02
Aa	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12
A	0.23	0.24	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21
Baa	0.31	0.32	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Ba	0.52	0.52	0.52	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50
B	0.65	0.66	0.65	0.65	0.65	0.65	0.64	0.64	0.64	0.64	0.63	0.63
Caa	0.93	0.94	0.94	0.94	0.94	0.93	0.92	0.92	0.92	0.91	0.91	0.91
Ca-D	1.42	1.42	1.41	1.42	1.41	1.40	1.39	1.39	1.41	1.41	1.40	1.40
Moody's Rating	2013											
	Jan	Feb	Mar	Apr	May	Jun						
Aaa	0.00	0.00	0.00	0.00	0.00	0.00						
Aa	0.11	0.10	0.10	0.10	0.10	0.09						
A	0.20	0.20	0.20	0.20	0.19	0.20						
Baa	0.28	0.28	0.27	0.28	0.27	0.28						
Ba	0.50	0.50	0.49	0.49	0.49	0.51						
B	0.63	0.62	0.62	0.61	0.61	0.60						
Caa	0.94	0.94	0.94	0.94	0.94	0.95						
Ca-D	1.38	1.37	1.35	1.36	1.36	1.33						

Source: Pratt and Grabowski, 2014

When calculating the levered beta for Aker BP, the estimated debt beta used was 0.53, which was the average debt beta based on the table above. Alternatively, it is common practise to set the debt beta to zero. However, if debt beta is zero it implies that the debt is risk free, and with Aker BP's credit ratings that would be an incorrect assumption.

The market value of debt was set to one, since the Valhall IP upgrade was financed with a bond loan that carried an interest of three month LIBOR, 2.58% (Bankrate.com) plus a margin of 6.81% (Aker BP, 2019).

2.4.4 Market Risk Premium

The market risk premium is the extra return on the risk-free rate, which is required by an investor to compensate for the risk in investing in an asset. The concept of market risk premium is related to the minimum rate investors should accept, measurement of historical return, and the investors expected return.

According to PWC (2018), the Norwegian market risk premium was 5% in 2018. Therefore, this thesis used the 5% market risk premium when calculating the Valhall IP upgrades return on equity.

2.5 Primary Valuation Approach

The primary valuation approach for the Aker BP Valhall IP Upgrade was the DCF method. This valuation approach provided a detailed analysis as it incorporated Aker BP's estimated assumptions and expectations in its calculations. In addition, CAPM and the payback method were used to provide more credibility to the overall valuation, by providing reassurances that the DCF models estimates and expectations were valid.

CHAPTER 3: THE OIL AND GAS INDUSTRY

This chapter presents an overview of the oil and gas industry, in order to illustrate the complexity of the world's energy demand. It also discusses the oil history of the Norwegian continental shelf and the formation of oil prices.

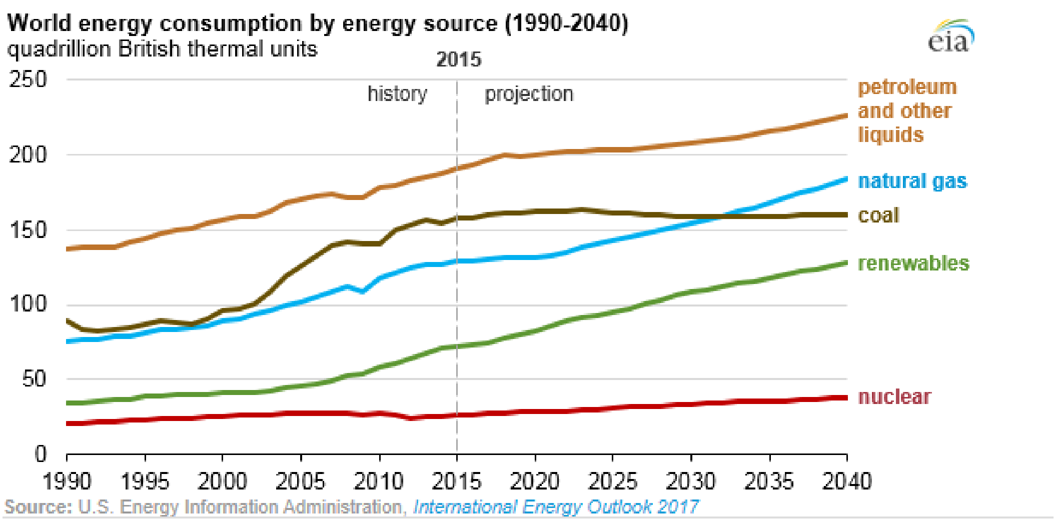
3.1 Oil and Gas Industry

Oil and gas are among the most important energy sources in the world. Oil accounts for 33% of global energy consumption and natural gas accounts for 24% of power generated worldwide (World Energy Resources, 2016). Moreover, the U.S Energy Information Administration (EIA) estimated that members of the Organisation of the Petroleum Exporting Countries (OPEC) earned approximately USD 567 billion in net export revenues in 2017 (EIA, 2018). For 2019, OPEC revenues are expected to be USD 719 billion, which is considered to be low, due to the recent decline in oil price.

3.1.1 Energy Demand

As the world's population grows, global energy demand increases. EIA projects that world energy consumption will grow by 28% between 2015 and 2040.

<u>Figure 2:</u> World energy consumption by energy source (1990-2040)



Source: U.S. Energy Information Administration, 2017

The major increase in oil demand is led by non-OECD (Organisation for Economic Co-operation and Development) Asian markets where China and India's oil thirst continues to grow. The two countries oil consumption will account for more than 60% of the world's total increase in energy consumption from 2015 to 2040. However, in China, alternative energy sources such as electricity and natural gas are displacing the need for oil so India is expected to become the second largest oil and energy consumer in the world behind the USA.

<u>Figure 3:</u> The world top 10 consumers of oil

The World Top 10 Consumers (*)
(thousand barrels/day)

	2000	2005	2010	2015	2016	2017	Δ y/y (2017-2016)	CAGR (2017-2000)
United States	19,999	21,168	19,476	19,840	19,999	20,188	0.9%	0.1%
China	4,651	6,772	9,031	11,562	11,809	12,445	5.4%	6.0%
India	2,336	2,632	3,297	4,241	4,560	4,679	2.6%	4.2%
Japan	5,357	5,164	4,328	4,120	4,026	3,942	-2.1%	-1.8%
Russia	2,678	2,732	2,947	3,450	3,533	3,557	0.7%	1.7%
Saudi Arabia	1,571	1,941	2,674	3,415	3,264	3,221	-1.3%	4.3%
Brazil	2,135	2,173	2,774	3,177	3,074	3,088	0.4%	2.2%
South Korea	2,135	2,191	2,269	2,473	2,630	2,654	0.9%	1.3%
Germany	2,767	2,624	2,467	2,368	2,410	2,504	3.9%	-0.6%
Canada	2,008	2,338	2,382	2,372	2,379	2,414	1.5%	1.1%
The World Top 10	45,636	49,735	51,644	57,018	57,684	58,692	1.7%	1.5%
Rest of the World	31,503	34,918	36,920	37,999	38,494	39,123	1.6%	1.3%
World	77,139	84,654	88,564	95,017	96,178	97,815	1.7%	1.4%

Source: ENI World Oil Review Volume 1, 2018

The long-term demand for oil in OECD countries is forecasted to decline due to technological improvements and the focus on reducing carbon emissions. Non-OECD countries are forecasted to continue driving demand growth, with China and India considered to be the two major oil-demanding countries.

3.1.2 Global Oil and Gas Supply

The Organisation of Petroleum Exporting Countries (OPEC) was established in 1960, with the main objective to coordinate policies on oil price and production. Before OPEC, major private companies also called the "seven sisters" (BP, Mobil, Chevron, Shell, Texaco, Gulf Oil, Esso) dominated the world's petroleum industry. During the 1970s, the strong influence of these companies started to decline and the OPEC cartels influence expanded steadily. In 2018, the daily production of crude oil by OPEC countries averaged 32.3 million barrels, 0.3 million b/d lower than 2017 (OPEC, 2018).

The world's top oil producing countries continue to be dominated by the following countries: United States (15.65 mbpd), Saudi Arabia (12.09 mbpd), Russia (11.21 mbpd) and Canada (4.96 mbpd). Despite facing competition from new energy solutions and political challenges, the top oil producing countries are expected to maintain their position in the global market going forward (EIA, 2018). Interestingly, Canada has passed China to become one of the top four oil-producing countries. The increase in oil production is primarily from oil sands production, which is costly and emits higher carbon emissions, compared to conventional methods such as extracting crude.

3.1.3 Norway Oil and Gas Supply

In 1969, Phillips Petroleum discovered the Ekofisk field and the Norwegian oil adventure began in earnest. In the initial stage, exploration in Norway was dominated by foreign companies, and in the mid -1980s, the Norwegian parliament reorganised the states participation in petroleum operations in order to protect its own interest. Presently, the states participation is split into two, with one part participating in the companies and the other becoming part of the financial interests of the petroleum industry (Regjeringen.no, 2016).

Since the petroleum industry started its activities on the Norwegian Continental Shelf (NCS), oil and gas have been produced from 106 fields. In 2018, 83 fields were in production with 63 in the North Sea, 18 in the Norwegian Sea and two in the Barents Sea (Norsk petroleum, 2018).

For the Norwegian economy, the oil and gas industry is an essential part of a sustainable future. According to the Norwegian Petroleum (2018), the policy has always been to provide profitable long-term production and ensure as much as possible of the value creation benefit the Norwegian society. The petroleum taxation system is one of the main factors that actually ensures the value creation is obtained. Petroleum tax is based on the ordinary 22% company tax and a 56% special tax, due to the extraordinary returns on production for petroleum resources. This means that the total tax rate for oil companies in Norway is 78%.

Figure 4: Norwegian petroleum tax rates 2013-2019 *Source: Aker BP, 2019*

Petroleum tax	2013	2014	2015	2016	2017	2018	2019
Company tax	28%	27%	27%	25%	24%	23%	22%
Special petroleum tax	50%	51%	51%	53%	54%	55%	56%
Total tax rate	78%	78%	78%	78%	78%	78%	78%

In general, the net profit is taxable. When the taxable income is calculated, investments are written off using straight-line depreciation over six years from the year the expense was incurred. In addition, uplifts are granted for capital expenditure, which represents a depreciation spread over four years. The uplifts are deductible only for the special petroleum tax (Aker BP, 2019).

Figure 5: Norwegian petroleum tax - nominal uplift rates 2013-2019

Uplift	2013	2014	2015	2016	2017	2018	2019
Uplift per year	5.5%	5.5%	5.5%	5.5%	5.4%	5.3%	5.2%
Total uplift over four years	22%	22%	22%	22%	21.6%	21.2%	20.8%
Special petroleum tax	50%	51%	51%	53%	54%	55%	56%
After tax value of uplift	11.0%	11.2%	11.2%	11.7%	11.7%	11.7%	11.6%

Source: Aker BP, 2019

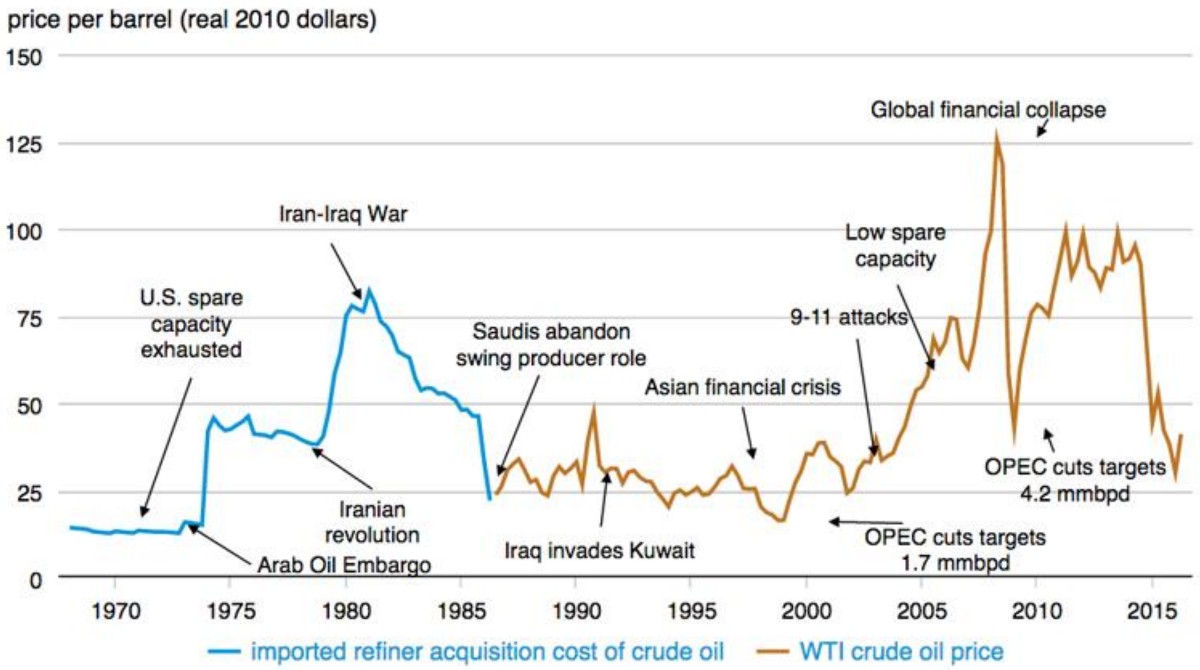
Petroleum activities on the NCS have contributed more than NOK 14 000 billion to Norway's GDP since the early 1970s (Norwegian Petroleum, 2018).

3.2 Oil Price Formation

Oil is a popular commodity among traders. When it comes to physical oil, the two most traded benchmarks are Brent North Sea Crude (Brent) and West Texas Intermediate (WTI), which are traded on the Intercontinental Exchange (ICE) and the New York Mercantile Exchange (NYMEX). Both Brent and WTI are classified as "light-sweet" crude (low density and low sulphur content) and they are the most valuable oil because they can be refined more easily and cheaply. Brent is extracted from the North Sea and comprises Brent Blend, Forties Blend, Ekofisk, and Oseberg crudes (also known as the BFOE Quotation). Crude oil is also handled via futures. Oil futures are contracts that agree on a set amount of oil, at a set price, on a set date. The contracts can be traded on futures exchanges and are notorious for their volatility.

Disruptions in the flow of oil to the market is often related to political conflicts. In fact, much of the world's crude oil is located in regions that have high exposure to political conflicts. This creates uncertainty about future supply and demand, which lead to higher volatility in the oil price. An overview of crude oil prices over the past 40 years indicates that supply disruptions in oil tend to drive prices.

Figure 6: Crude oil prices and geopolitical and economic events



Source: U.S Energy Information Administration, 2019

OPECs crude oil production is an important factor that affects the oil price. The organisation does not want excessive oil prices in either direction, high or low, and effectively manages oil production by setting production targets. According to OPEC (2018), 82% of the world's proven oil reserves (1, 214.21 billion barrels) are located in OPEC member countries, with the bulk of OPEC oil reserves in the Middle East. By comparison, the oil reserves of non-OPEC countries currently stand at 268.56 billion barrels.

Other important factors that determine oil prices are the U.S petroleum consumption and the growth in emerging markets (in Asia in particular). The EIA (2019) forecasts that total U.S petroleum consumption will average 20.8 million barrels per day (b/d) in 2019, an increase of 310.000 b/d (1.5%) from 2018. Consumption is forecasted to grow by 240.000 b/d (1.1%) in 2020. The volatility in oil price makes it difficult to predict future oil prices, but it is expected that Brent prices will average USD 65 per barrel (b) in 2019 and USD 62/b in 2020. WTI prices are forecasted to be USD 4-8/b lower than Brent price (EIA, 2019).

Despite the current lower oil prices, investments in oil and gas still offer the potential for higher returns than many other traditional investments. In this sense, any change in oil prices will affect the valuation of Aker BP's Valhall IP upgrade. Taking into consideration that oil prices are sensitive to geopolitical events, consumption, demand, reserves, and other macroeconomic factors, the oil price for this study is USD 65/b, as per the EIA forecast.

CHAPTER 4: AKER BP ASA

This chapter provides an overview of the background, strategy and the historical share price development of Aker BP. It also describes the Valhall field located in the Norwegian North Sea.

4.1 Background

The history of Aker BP started with the establishment of the oil company Pertra AS in 2001 and Det Norske Oljeselskap (DNO) in 1971.

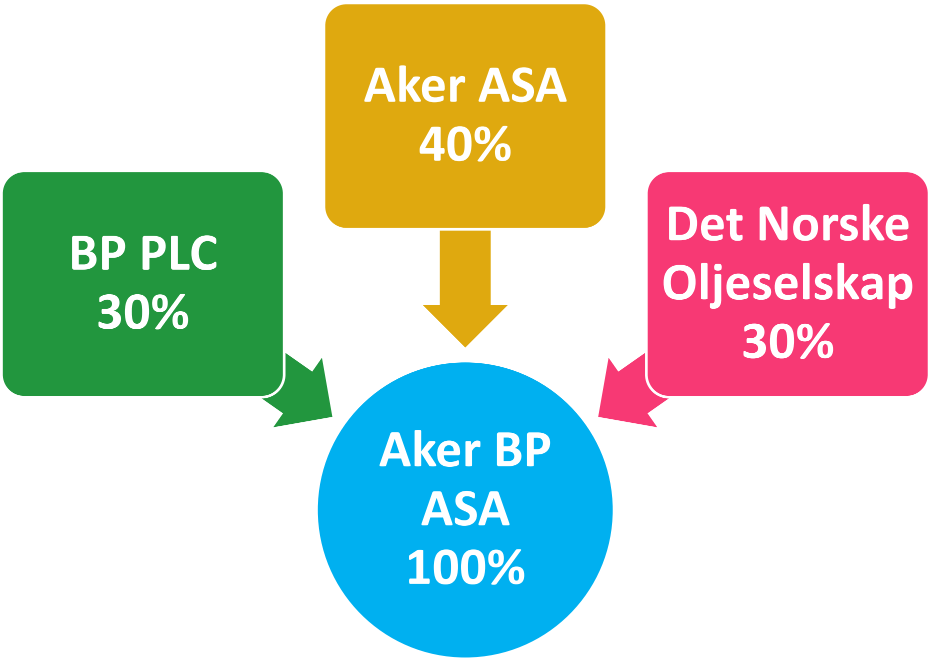
Pertra AS was founded by Petroleum Geo-Services (PGS) as an exploration and production (E&P) company, with a focus on the Norwegian Continental Shelf. In 2005, PGS sold Pertra AS to the Canadian company Talisman Energy. Soon after, the Pertra AS management team established a new company, Pertra Management AS. In 2006, Pertra Management AS was converted into Pertra ASA, a public limited corporation.

In 2007, Pertra ASA and the Norwegian interests in DNO decided to merge, and formed the company NOIL energy. The two companies were formally merged in 2008 under the name Det Norske Oljeselskap ASA (DNO ASA). In 2009, Aker Exploration became the major shareholder in DNO and the merger of DNO and Aker Exploration was approved at the companies' extraordinary general meetings.

In June 2014, DNO acquired Marathon Oil Norway. The transaction was a strategic move, which secured several new licenses and the operation of the Alvheim and Bøyla fields.

In June 2016, DNO ASA and British Petroleum agreed to merge with BP Norge AS through a share purchase transaction, with the main goal to create a leading independent offshore E&P company. The company changed its name to Aker BP ASA and is listed on the Oslo Stock Exchange (OSE) under the symbol AKERBP (Aker BP, 2018).

Figure 7: Distribution of Aker BP ASA shareholders



Source: Aker BP, 2016; own creation

Aker BP has been through extensive integration work since the merger and as a result, the company has strengthened its operations and become a more cost-efficient organisation. The company operational activities includes exploration, development, and production of oil and gas (upstream segment) and it has considerable future ambitions in the NCS.

4.2 Strategy

As of 2018, Aker BP's strategy was to create the leading independent offshore E&P company by continuing to focus on execution, improvement, and growth with high health, safety and environmental (HSE) standards as the foundation of all its activities. In order to achieve this goal, its strategy focused on the following elements:

- Increase market share as the key operator on the NCS
- Field development and cost leading solutions
- Reorganise the value chain by entering strategic partnerships and alliances
- Developing digital transformations and supporting automated operations
- Merger and acquisitions (M&A) strategy and portfolio management
- Returning value to shareholders through increasing dividends

At the end of 2018, Aker BP's total income had increased by 47 percent from 2017 and all major field development projects had progressed as planned. The company is continuing to build on a strong platform for further value creation through safe operations and an effective and lean business model (Aker BP, 2018).

4.3 Share Price

Since the merger and establishment of Aker BP in September 2016, its share price has continued to rise. The yearly development of its share price from September 2016 is presented in figure 8 below.

Figure 8: Yearly development of share price Aker BP

Source: Hegnar, 2019

Stock prices change every day due to market forces. However, no person can predict with precision a stock prices behaviour in the future.

"I know what markets are going to do over a long period of time: They're going to go up. But in terms of what's going to happen in a day or a week or a month or a year even, I've never felt that I knew it and I've never felt that was important"

(Warren Buffet, 2016)

Figure 8 illustrates a relatively high growth rate in recent years. According to Odean (2007), investors do not purchase every single stock that grab their attention, but investors are more likely to purchase attention-grabbing stock than to sell them. Aker BP's popularity can be associated with attention-grabbing events in recent years such as news, high trading volume and high returns.

4.4 Current Market Position

In the span of a few years, Aker BP has repositioned the company to become a leading independent E&P company in Europe. In 2018, its net oil production reached 155.7 thousand barrels per day. Total production volume was 56.8 million barrels of oil equivalent ("BOE"). With a strong balance sheet, capital flexibility, and robust investment program Aker BP is well positioned across the market. Moreover, the company paid dividends of USD 450 million in 2018, with an intention to increase the dividend levels by USD 100 million every year until 2023 (Aker BP, 2018).

Figure 9: Aker BP's strategic ambitions

Source: Aker BP, 2018

Considering Aker BP's brand positioning and proactive approach the company's outlook demonstrates significant growth potential and could strengthen its position in the market as one of the largest independent oil companies in Europe.

4.5 Valhall Field

Valhall field was discovered in 1975 and came online in 1982. The field is located in the southern part of the Norwegian North Sea and the complex consists of six separate steel platforms which are all bridge connected. Approximately 6 kilometres north and south of the fields center, two unmanned flank platforms (North and South) are located, remotely operated from Valhall. 13 kilometres away from Valhall is the remotely operated wellhead platform Hod. At present, Hod produces oil from wells drilled from the Valhall Flank South platform. All wells on the Hod platform are currently shut-in and waiting to be plugged and abandoned (Aker BP, 2017).

In 2017, Valhall and Hod passed one billion BOE (159 million Sm3). This was more than three times the volume expected when the field was opened in 1982. In the fourth quarter of 2018, production from Valhall and Hod combined was 39.6 thousand BOE per day, representing a 10 percent increase from the previous quarter. The operating efficiency is high and Aker BP estimates that Valhall can produce a further one billion barrels through increased oil recovery, new technological innovations, flank developments and improved drilling efficiency (Aker BP, 2017).

Figure 10: Valhall area key figures Q4-2018 report

Valhall Area

Key figures	Aker BP interest	Q4 2018	Q3 2018	Q2 2018	Q1 2018
Production, boepd					
Valhall	90 %	38 816	35 120	32 670	33 500
Hod	90 %	802	872	1 063	1 016
Total production		**39 618**	**35 993**	**33 733**	**34 515**
Production efficiency		91.1 %	87.6 %	84.5 %	84.7 %

Source: Aker BP, 2018

In order to increase the activity levels at Valhall a key goal is to optimise well design and the efficiency of drilling operations on Valhall IP. The plan is to install a fully robotic pipe handling system that consists of a utility package, and a new automated drilling control system to enable autonomous and automated drilling.

CHAPTER 5: CANRIG ROBOTIC TECHNOLOGIES AS AND VALHALL IP UPGRADE

This chapter will give a brief presentation of Canrigs background and its drilling system technology. It also introduces description and specifications of the planned robotic drill floor equipment on Valhall IP fixed platform is introduced.

5.1 Background

Robotic Drilling Systems (RDS) is a local Sandnes based technology company, established in 2005 by the founder Lars Raunholt. The company develop drill floor solutions by optimising drilling workflows through automation. This technology can be used on all drilling structures for both land and offshore installations. Since 2005, the company has continued to grow its business and with an infusion of cash derived from the sale of shares, new shareholders such as Odfjell Drilling, Statoil Technology Invest, Investinor and Westcon have boosted the expansion and development of advanced robotic drilling technology and control systems.

In 2017, RDSs shareholders entered into an agreement to sell all shares in RDS to Nabors Industries (Nabors). The transaction integrated the RDS team and products with the technology portfolio of Canrig, Nabors rig equipment subsidiary. In addition, Nabors and Odfjell Drilling signed a memorandum of understanding for strategic cooperation that granted Odfjell Drilling access to RDSs robotic technologies for existing and future drilling rigs. Founded in 1952, Nabors conducts oil, gas and geothermal land drilling operations and is the largest land drilling contractor in the world. It is also a leading provider of offshore platform workover and drilling rigs in the U.S (Nabors, 2019). Nabors is a publicly traded company on the New York Stock Exchange (NYSE), with the ticker symbol NBR.

5.2 Robotic Drilling System Technology

Canrig has developed a robotic drill floor system consisting of four components: Robotic pipe handler (RPH), robotic roughneck (RRN), drill floor robot (DFR) and multi-size elevator (MSE). Sixteen patents protect the innovative technology of the four components, together with other exclusive intellectual property rights.

Studies indicate that introducing robotic equipment on the drill floor can save rig time and eliminate manual operations on the drill floor. The robots can carry out pipe, casing, and tool handling tasks in a safe, fast, consistent and precise manner. The technology also includes a proposed robotic solution to the pipe deck for achieving smooth operations. Bottom hole assembly (BHA) make-up and break-out, tripping slips-to-slips, and casing running are identified as key operations where Key Performance Indicators can be significantly improved by introducing robotic technology. In addition, other operations in the well construction process can also benefit from this technology.

RDS and Aker BP have studied a number of technical future concepts and the proposed alternative layout is described as a state-of-the-art game changer solution that will enable digitalisation of the operations with a high degree of autonomy and hands-free operation. The estimated cost of the robotic drill floor system is 170 million NOK.

5.3 Robotic Drilling System Description

A new RPH, RRN, MSE and DFR will replace the existing pipe racker, iron roughneck and elevator on the Valhall IP. A new Pipe Deck Handler (PDH) will be installed on the pipe deck to move tubulars between the drill floor and pipe deck.

The Robotic Control System (RCS) enables cooperation between individual robots, while at the same time interfaces with other equipment on the rig and maintains anti-collision and safety. Each individual robot has an industry standard emergency stop system and can be included in the existing Valhall IP emergency stop loops.

5.3.1 Robotic Pipe Handler RPH-7000

The RPH-7000 has two identical, independent manipulator arms that travel on the same vertical column. Each manipulator arm has two Spinner Grippers that can grip and spin pipes from 4 to 14 inches. The manipulators can automatically change the Spinner Grippers for other pipe sizes.

The RPH-7000 handles drill pipes, drill collars without spirals, casings and tubes from horizontal to vertical positions or to and from setbacks. It spins the tubulars into the stick-up, thereby integrating the pipe lifting, pipe racking, and spinning operation into one machine. It can also handle shorter subs/BHA components with a single Spinner Gripper.

The RPH-7000 will be capable of building stands of drill pipe, casings and tubes in parallel with drilling or tripping. Two torque wrenches mounted on the vertical column or in the derrick can torque drill pipes or casings up to 100 kNm (Nabors, 2019).

The main features of the RPH-7000 are as follows:

- Fully electrical, nine axis robots for pipes and casing.
- Low maintenance requirements.
- Multi-size grippers with spinning capabilities.
- Lower arm/gripper that can be used for BHA components and lifting subs.
- Handle stands (2x and 3x).

Figure 11: RPH-7000

Source: Nabors, 2019

5.3.2 Drill Floor Robot DFR-1500

The DFR-1500 is a flexible 6-axis robot mounted on a linear rail (7^{th} axis) that ensures a large working range and great flexibility. With its unique Robot Tool Spinner Grippers, the DFR can spin objects such as lifting subs, x-overs, and stabilizers directly into or out of stick-up or other objects. For example, it can spin in a lifting sub off a BHA sub-assembly.

The robots tool interface has two independent mechanical couplings, allowing for a range of different tool options. It can also change tools by itself, without manual assistance (Nabors, 2019).

The main features of the DFR-1500 are as follows:

- Fully electrical with 1500kg capacity.
- Rapid tool exchange.
- Low maintenance required.
- High speed and accuracy.
- Seven axis motion.

Figure 12: DFR-1500

Source: Nabors, 2019

5.3.3 Robotic Roughneck RRN-250

The RRN-250 has individually height adjustable torque wrenches and backup-tongs to handle BHAs and other challenging make and break operations, in addition to the regular torqueing of pipes. The RRN's ability to handle high torque eliminates the need for manual tongs. The RRN has a make-up and break-out torque exceeding 270 kNm.

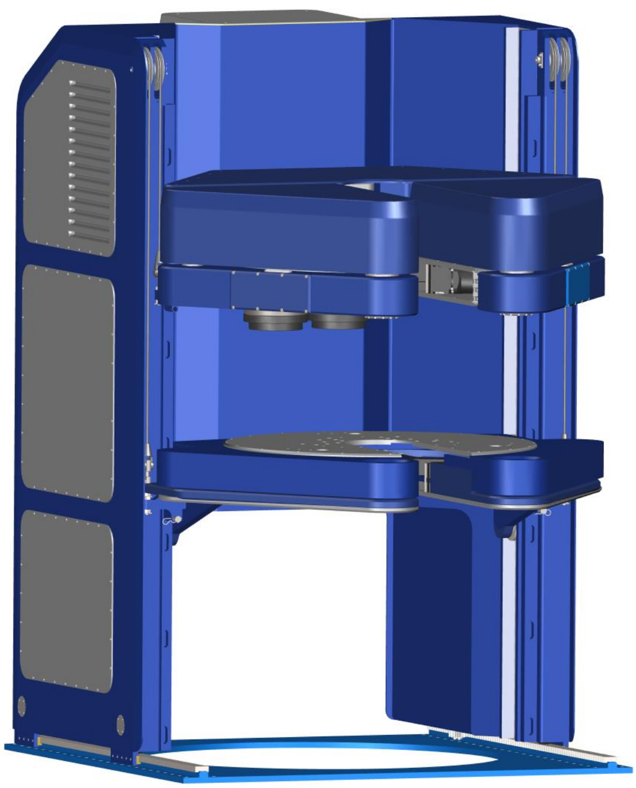
The all-electric make/break and clamping functions allows for the application of accurate torques in accordance with tubing manufacturer recommendations.

Its large range from 4 to 14 inches, allows the RRN to torque casings. Combining data from the RPH's Spinner Grippers with the data from the RRN gives a complete torque-turn curve for the connection (Nabors, 2019).

The main features of the RRN-250 are as follows:

- Fully electrical with 270 kNm capacity.
- Automatic operation.
- Triple-grip torque wrench with high accuracy.
- 120 degrees total rotation per grip.
- Ability to handle casing.

The RRN is the world's first fully electrical robotic roughneck and replaces the need for casing crews and manual tongs.



<u>Figure 13:</u> RRN-250

Source: Nabors, 2019

5.3.4 Multi Size Elevator MSE-500

The MSE-500 is designed to handle all the necessary pipe dimensions (between 2.875" and 13.375") for drilling a section of the well with the use of 4 sets of latches for all sizes of tubulars with collars used on the Valhall IP, (excluding flush or semi-flush tubulars), along with configurable inserts. The inserts are shifted by remote controls when new objects are handled thereby eliminating manual operations and potentially saving up to five to ten minutes per shift.

The MSE works seamlessly with the pipe handler to ensure a fast and safe transfer of objects, through the weight negotiation feature of the robotic control system. The feature allows the elevator to measure the weight of the stand or assembly (Nabors, 2019).

The main features of the MSE-500 are as follows:

- Automatic operation
- 90 degrees tilt function
- 500 Short ton (US ton) capacity
- Handles multi size tubulars
- Wireless control system

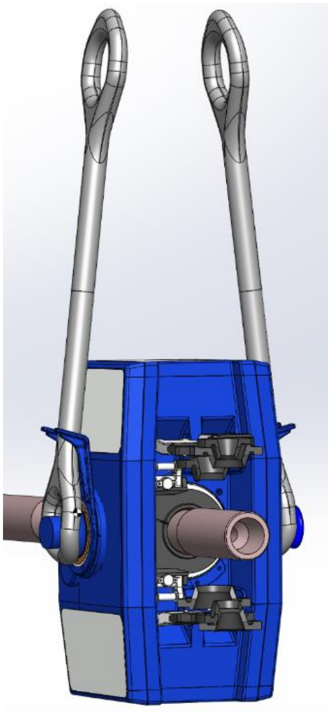


Figure 14: MSE-500

Source: Nabors, 2019

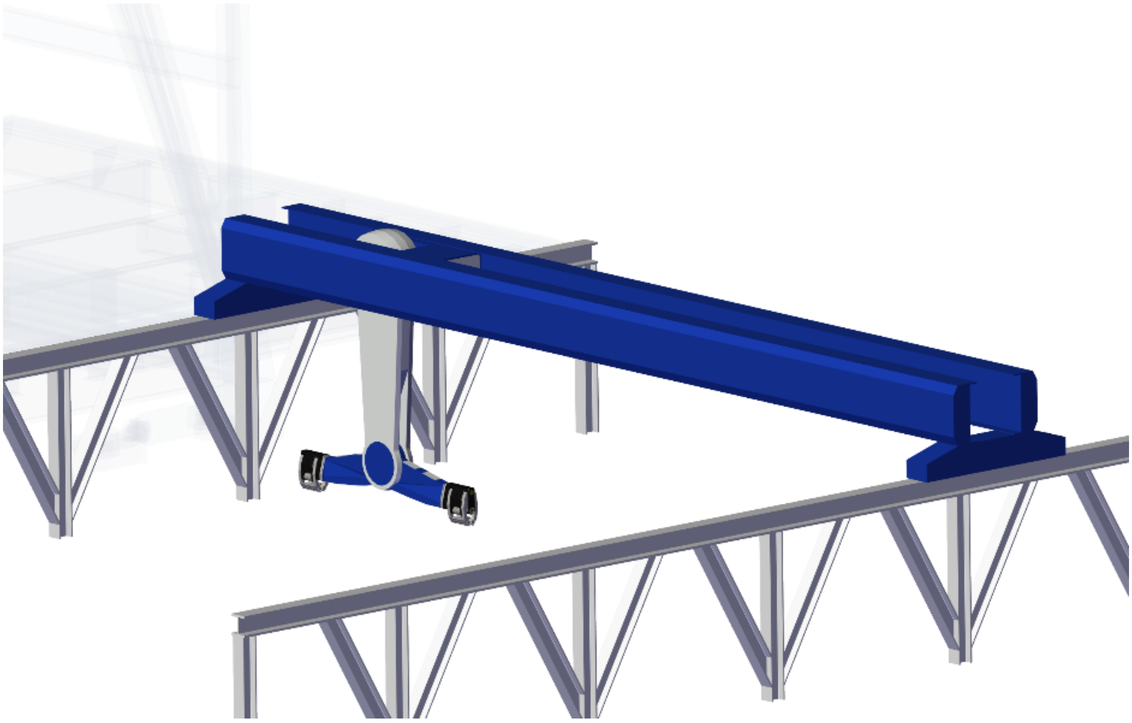
5.3.5 Pipe Deck Handler PDH-3500

The PDH-3500 picks up pipes and subs either from pre-loaded magazines, or directly from the pipe deck. Pipes or subs are delivered directly to the RPH-7000 on the drill floor, without the need for a pipe feeding machine. Heavy objects can be shuttled into the pipe deck through an add-on shuttle on the pipe deck manipulator arm. The PDH enables automatic handling of tubulars and BHA components from pipe deck to drill floor, without the need for cranes, wires, and manual operations. The preloaded pipe magazines makes it possible to handle pipes from ships onto the pipe deck in a safe and efficient manner (Nabors, 2019).

The main features of the PDH-3500 are as follows:

- Fully electrical, nine axis robot for pipes and casing
- 3500 kg lifting capacity
- Capable of spinning stands
- Low maintenance requirements
- Self-containment with hardware controls, allowing for easy installation

Figure 15: PDH-3500



Source: Nabors, 2019

5.3.6 Robotic Control System

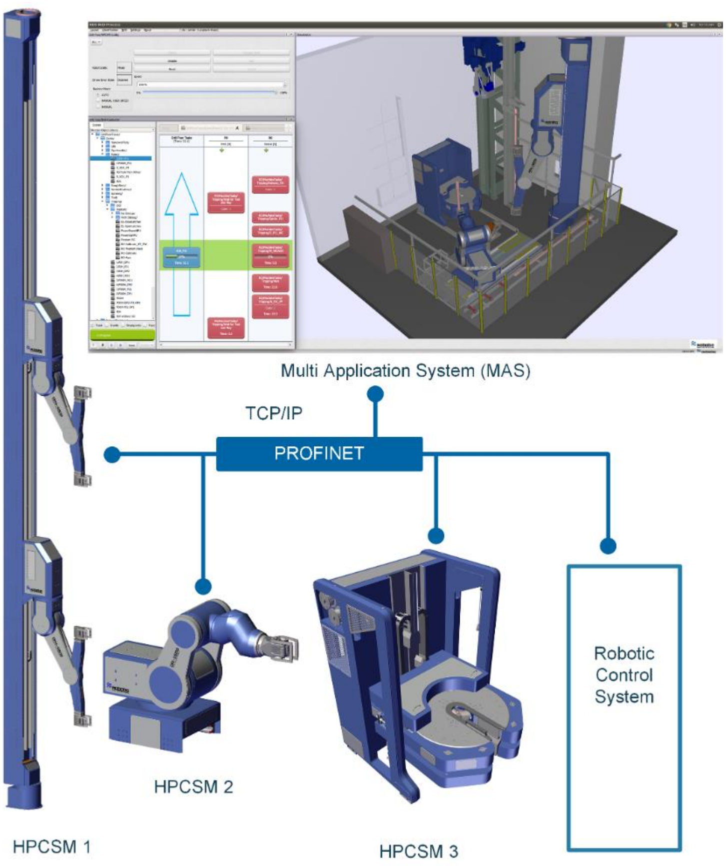
The RCS is capable of full robotic system collaborations and parallel operations. These features allow for high level drill floor and pipe deck executions such as automatic tripping of in/out stands, adding/removing subs to/from the well center, and making BHAs.

The operator interacts with a self-explaining and intuitive touch interface for high-level task execution, but he or she also has enough freedom to perform manual machine specific operations with ease. The touch screen is installed within an arm's reach from the driller's operator station. Optionally, a wireless remote control unit allows for special operations on the drill floor and pipe deck with robots in reduced safe speed.

The robots are capable of programming motion by themselves in real-time. They automatically figure out how to move between targets and obstacles. A 3D virtual rig model is embedded into the control system and delivers a state-of-the-art collision avoidance functionality. Non-robotic machines can be modelled and integrated with the collision system, as well as displayed on the operator screen, so as to significantly reduce the time needed to return to normal operations after a stop. Standardized safe interfaces allow external actors to integrate robot control and status into the existing system, retrieve high quality data logs, and stream data onshore.

The system redefines the role of the driller, so that he/she can focus on the important drilling tasks and not on pipe and tool handling (Nabors, 2019)

<u>Figure 16:</u> RCS



Source: Nabors, 2019

5.4 Personnel Support

Due to the projects complexity, the work required to integrate robotic drilling systems on Valhall IP will require extensive installation and commissioning supervision and support. In the first year of operation, it is also necessary to have contractor personnel on standby both offshore and onshore.

The installation supervision and support requirements are as follows:

- Installation manager (2 total) day and night for 21 days offshore.
- 2 teams with 2 people each day and night (8 people total). Technicians for installing equipment for 14 days offshore.
- 1 team with 2 people day and night (4 total). Technicians for electrical wiring and power for 14 days offshore.

The commissioning supervision and support requirements are as follows:

- Installation manager during the day for 60 days offshore.
- Technician support day / night for 60 days offshore.
- HW support during day shift for 60 days offshore.
- 2 person SW teams day / night for 60 days offshore.

The requirements for contractor personnel on the rig for the first year are as follows:

One engineer/technician (one shift) must be on the rig during the full first year of operations, to repair or upgrade systems immediately if possible, and to identify any problems and mobilize necessary resources from land.

CHAPTER 6: STRATEGIC ANALYSIS

The purpose of this chapter is to provide a framework for strategic analysis of the Valhall IP upgrade. The strategic analysis provides an important overview of the project and highlights some of Aker BP's ambitions as an international E&P company. Furthermore, the strategic analysis is conducted through a SWOT analysis.

6.1 Framework for Strategic Analysis

To understand the purpose of the strategic analysis, it may be reasonable to provide a definition of the purpose of strategic analysis in an organisational environment. Johnson et.al, (2017) provides the following definition:

"Strategy is the long-term direction of an organisation that includes two advantages. First, the long-term direction can include deliberate, logical and emergent patterns of strategy. Second, long-term direction can emphasise difference and competition or recognise the roles of cooperation and imitation".

In other words, strategy is a direction typically measured over years and suggests particular elements, which are key value drivers in the organisations environment. This definition will be the core for analysing the Valhall IP upgrade. A SWOT-analysis is conducted to gain an overall picture of the project. The SWOT analysis identifies the projects internal strength and weaknesses, and the external opportunities and threats.

6.2 SWOT Analysis of Valhall IP Upgrade

The four parameters of the SWOT analysis are as follows:

- Strengths refer to the characteristics of the projects advantages over others
- Weaknesses refer to the projects disadvantages relative to others projects
- Opportunities refer to events that the project can benefit from
- Threats refer to elements that can seriously affect project performance

6.2.1 Strengths

As part of Aker BP's digitalisation and automation strategy, enabling fully automated drilling on Valhall IP will strengthen the platforms position and performance on the NCS for years to come. The robotic pipe handling system can save rig time by faster tripping and tubular handling, compared to the conventional methods used today. A summary of the Non-productive time (NPT) on Valhall IP G-22, G-11, G-17, G-20 and G09 can be found in Appendices A, B, C, D, E. In addition, tripping data – slip-to-slip connections on G-22, G-11 and G-17 can be found in Appendix F. Tripping data – slip-to-slip connections for G-20 and G-09 are not available. The summaries confirm that current conventional drilling methods on Valhall IP have significant potential for increased operational efficiency. Moreover, the new system enables accelerated production from future wells and increases oil reserves by efficient drilling. Preliminary studies performed by Aker BP indicate potential savings of more than 2000 manual operations in typical drilling and completion operations. The advantages gained by the introduction of automated drilling are considered to be a significant strength to the company and Valhall IP.

At present, Valhall is under high pressure regarding the personnel on board. The operational drilling system (MH Wirth) is outdated and requires costly maintenance, software upgrades, and extra personnel in order to function in an efficient manner. With the introduction of an automated drilling control system, less offshore personnel are required and the maintenance costs of the old MH Wirth system are eliminated. These factors are considered to be a strength of the project, as they help to lower production costs.

Another strength of enabling fully automated drilling on Valhall IP is that it complies with Aker BP's HSE expectations. The company has ambitious objectives, but realises that these objectives cannot be achieved without safe operations. This is considered to be a strength because the ability to promote a culture that focuses on safety and eliminates unintentional incidents. In addition, the contractor and its subcontractors have implemented a Quality Management System according to ISO 9001, and established a Quality Plan in accordance with ISO 10005, that secures compliance with all relevant laws, rules and regulations. This is considered to be a strength due to the open communication and quality control plan commitment between Aker BP, its contractors and subcontractors.

6.2.2 Weaknesses

The Valhall IP upgrade is a "one of a kind" project on the NCS. Even though the automated drilling system can contribute to making production more efficient and safer, the project is associated with relatively high development and building risk. The contractor is responsible to complete the work in accordance with agreed schedules, which has to be in compliance with the HSE requirements of the Norway Petroleum Safety Authority, company specifications, NORSOK/ISO Standards, and Industry Codes and Standards. These factors combined could possibly result in installation delays, or personnel suffering serious injuries from accidents because of tight deadlines.

Furthermore, 4 months of drilling stoppages are planned on Valhall IP due to the installation and upgrade of the platform. If the project faces unexpected installation and start-up challenges, this could negatively affect Aker BP and the Valhall IP's oil productivity.

The automated drilling system is based on robots performing tasks according to human instructions. According to Asada (1996), a central issue in robotics is to facilitate communications with humans, so that human intentions and task goals can be transferred to robots easily and efficiently. Highly advanced robot technology requires higher workloads, longer periods of job training, and a longer time for programming, debugging, and diagnosis. Even though the contractor is responsible for all aspects of the work, there are a few drawbacks in the projects execution of onshore/offshore programming, coordination of dedicated personnel, and the training plans for the systems users.

6.2.3 Opportunities

Aker BP has proven to be an ambitious company in recent years, by growing through several successful mergers and acquisitions. At present, the company is switching its emphasis from mergers and acquisitions, towards exploration and its current resources. In an interview with Reuters CEO Karl Johnny Hersvik made the following comments:

"Back in 2015-2016, we acquired resources for 50-60-70 cents a barrel, which is really hard to drill out on the NCS. Now, drilling and data acquisition cost have come down and the acquisition costs of the equivalent contingent resources have gone up, it makes sense to explore".

From the opportunity point of view, this is in consistent with the Valhall IP upgrade, which can effectively increase exploration and recovery, and lead to increased profits.

Another opportunity with the project is that it explores possible areas of cooperation and alliances with other innovative technological companies. The project is capable of enabling digital transformation in the drilling sector, which can contribute to Aker BP expanding its market position as a key player in the oil and gas industry.

6.2.4 Threats

One of the major threats to the Valhall IP upgrade is the competition from other robotic drilling suppliers. Service companies such as National Oilwell Varco, Sekal AS and Precision Drilling Cooperation are all developing state-of-the-art robot technologies that provide similar functions as the RDS. If the RDS faces serious installation and operational issues, this could potentially cause a significant downturn for all parties involved in the project.

Another possible threat for Aker BP and the Valhall IP upgrade could be the global energy demand as mentioned in Chapter 3.1.1. Even though the EIA estimates 28% growth in world energy consumption between 2015 and 2040, demand for alternative energy sources such as electricity and natural gas have significantly increased in the past decade. The OECD countries are driving the interest in technological improvements, while non-OECD countries drive the growth in oil demand. If the global consumption of oil should decrease, it might not be worthwhile for Aker BP to invest in major rig upgrades.

The main findings of the SWOT analysis are presented in figure 17.

Figure 17: SWOT analysis of Valhall IP upgrade

Internal Factors	
Strengths	**Weaknesses**
Increased productivity	Installation and start up risk
Safe operations (HSE)	Software issues
Reduce operational costs	Coordination of personnel
Quality control management	Training of personnel
External Factors	
Opportunities	**Threats**
Investing in technological improvements	Substitutes of robotic technology
Increase exploration and recovery	Decreasing oil demand
Market growth	Alternative renewable energy sources

Source: Johnson, et.al., 2017; own creation

CHAPTER 7: VALUATION OF VALHALL IP UPGRADE

This chapter conducts the valuation of the Valhall IP upgrade. The valuation is based on the valuation framework discussed in Chapter 2. Discounted Cash Flow will be the primary valuation method. Due to the complexity of the Valhall IP upgrade, several assumptions and limitations have been made to the calculation.

7.1 Calculating Cost of Equity

Risk Free Rate

A risk-free rate of 1.88% was established by using the average of 10-year Treasury bonds for 2018, which was published by Norges Bank.

Beta

The beta is estimated by the following two approaches:

- In April 2019, E24 published a 2.29 beta of one year for Aker BP.
- The beta was calculated by applying the equation 8 given in Chapter 2.4.3.

$$\beta = 1.03 + 1*(1.03 - 0.53) = 1.53$$

This study uses the calculated beta of 1.53.

Market Risk Premium

The market risk premium of 5% was used in this calculation, in accordance with the explanation in Chapter 2.4.4.

Combining all the components, that is the risk-free rate, beta and market risk premium rate, it is now possible to calculate the return on equity by using Equation 7:

$$0.0188 + 1.53*(0.05) = 0.0953$$

This is lower than Aker BP's expected cost of equity, which is 10%. However, the difference is considered to be relatively marginal, and in this case provides a reassurance that the calculated levered beta and CAPM is in line with Aker BP's capital structure.

7.2 Discounted Cash Flow Valuation of Valhall IP Upgrade

The DCF valuation analysis for 7 (minimum) and 23 (maximum) wells drilled on Valhall IP is based on the following estimates and limitations:

- The investment cost is set as a lump sum and does not show individual contract prices.
- Valhall IP platform will be off-line for 4 months during the upgrade.
  - Rig spreadcost is 3.4 million NOK/day * 120 days.
- The yearly increased productivity is based solely on oil production performance.
  - See Appendix I and J for calculations of the positive effect only.
  - Oil price is USD 65 per barrel.
- There are operational costs savings by investing in RDS.
  - 66 days rig downtime w/rig spreadcost of 3.4 million NOK/day.
- The upgrade is financed by an unsecured bond loan.
  - Three month LIBOR, 2.58% + 6.81% margin.
- Variable and fixed costs are estimated by Aker BP.
- 10-year service costs are estimated by Aker BP and financed with equity.
  - 30% of RDS cost (170 million NOK).
- Aker BP writes off investments using six-year straight-line depreciation.
- Total tax rate consists of company tax and special petroleum tax. The uplift is excluded.
- Aker BP does not account for working capital on the project level.
- The robotic drill floor system life cycle is expected to be 25 years.
- Aker BP's return on investment rate is 10%.

Table 2: DCF valuation of Aker BP Valhall IP Upgrade 7 wells

Aker BP Valhall IP Upgrade 7 Wells Scenario

(NOK)	0	1	2	3	4	5	6	7	8	9	10
Investment costs	-826 000 000										
Valhall IP off- line costs	-408 000 000										
Increased Oil Productivity		0	0	203 797 800	0	0	0	0	0	0	0
Reduction of operational costs		224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000
Bank loan (9.39%)		-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400
Variable costs		-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000
Fixed costs		-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-52 500 000
Depreciation	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666					
Earnings before taxes (EBT)	-1 371 666 666	6 171 934	6 171 934	209 969 734	6 171 934	6 171 934	143 838 600	143 838 600	143 838 600	143 838 600	92 838 600
Total tax rate (78%)		-4 814 109	-4 814 109	-163 776 393	-4 814 109	-4 814 109	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-72 414 108
Earnings after tax (EAT)		1 357 825	1 357 825	46 193 341	1 357 825	1 357 825	31 644 492	31 644 492	31 644 492	31 644 492	20 424 492
Bank loan	826 000 000										
Depreciation	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666					
Total projected cash flows	-408 000 000	139 024 491	139 024 491	183 860 007	139 024 491	139 024 491	31 644 492	31 644 492	31 644 492	31 644 492	20 424 492
Present value	-408 000 000	126 385 901	114 896 274	138 136 745	94 955 598	86 323 271	17 862 491	16 238 628	14 762 389	13 420 354	7 874 526
Net present value	237 748 517										
Internal rate of return	Not Applicable										

Source: Own Creation

Table 3: DCF valuation of Aker BP Valhall IP Upgrade 23 wells

Aker BP Valhall IP Upgrade 23 Wells Scenario

(NOK)	0	1	2	3	4	5	6	7	8	9	10
Investment costs	-826 000 000										
Valhall IP off- line costs	-408 000 000										
Increased Oil Productivity	0	0	0	326 076 400	264 937 100	509 494 400	203 797 800	142 658 400	40 759 600	20 379 800	20 379 800
Reduction of operational costs	0	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000
Bank loan (9.39%)		-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400
Variable costs		-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000
Fixed costs		-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-52 500 000
Depreciation	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666					
Earnings before taxes (EBT)	-1 371 666 666	4 671 934	4 671 934	330 748 334	269 609 034	514 166 334	346 136 400	284 997 000	183 098 200	162 718 400	111 718 400
Total tax rate (78%)		-3 644 109	-3 644 109	-257 983 701	-210 295 047	-401 049 741	-269 986 392	-222 297 660	-142 816 596	-126 920 352	-87 140 352
Earnings after tax (EAT)		1 027 825	1 027 825	72 764 633	59 313 987	113 116 593	76 150 008	62 699 340	40 281 604	35 798 048	24 578 048
Bank loan	826 000 000										
Depreciation	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666					
Total projected cash flows	-408 000 000	138 694 491	138 694 491	210 431 299	196 980 653	250 783 259	76 150 008	62 699 340	40 281 604	35 798 048	24 578 048
Present value	-408 000 000	126 085 901	114 623 547	158 100 150	134 540 437	155 716 673	42 984 694	32 174 675	18 791 666	15 181 867	9 475 901
Net present value	420 647 058										
Internal rate of return	Not Applicable										

Source: Own Creation

Table 2 and 3 shows the DCF of 7 and 23 wells drilled on Valhall IP. The tables are limited to 10 years, but the full calculations can be found in Appendix G and H. In this case, the NPV is positive and the project should be accepted. The IRR is not applicable for this project because multiple IRRs cash flow values are either negative or positive within the investment period. The only choice in the two scenarios is to rely on the NPV.

7.3 Payback Method of Valhall IP Upgrade

The preliminary pre-study results (Valhall IP 2.0 March 2018) do not necessarily reflect the opinions of Aker BP. The results illustrated in Table 2 indicates a theoretical, calculated tripping performance based on assumed positions, assumed operational sequences, and average performance of the machines.

Table 4: Estimated rig downtime savings per year

Activity	Hours	Days	% of rig activity	% saved rig time	Days saved / year	Comments
Tripping	1 381	57,6	15,8	9,5	34,5	60% saved
Drilling	1 086	45,3	12,4	0,4	1,5	15 000m drilled => 536 connections. ~4min saved per connection => 36hrs saved
R/U for casing/tubing	91	3,8	1,0	0,5	1,9	50% saved
Casing running	254	10,6	2,9	1,4	5,3	50% saved
BHA P/U & L/D	154	6,4	1,8	0,4	1,6	25% saved
BHA Handling	98	4,1	1,1	0,4	1,6	40% saved
Pick up from pipe deck	173	7,2	2,0	1,0	3,6	50% saved
Lay down to pipe deck	36	1,5	0,4	0,2	0,8	50% saved
Rigser/Rigrep	450	18,8	5,1	1,3	4,7	25% saved
Other activities	5 038	209,9	57,5	2,9	10,5	5% saved
TOTAL				**18,1**	**66,0**	
Year	8 760	365				

Source: Aker BP, 2018; own creation

Based on the results from the preliminary pre-study report, it is estimated that a saving of 66 days per year can be achieved by the installation of robotic drilling systems compared with the existing drill floor solution. This includes slot recovery and drilling on the Valhall IP.

The Valhall IP rig spread cost is estimated to be 3.4 million NOK/day, which yields potential yearly savings of 3.4 million NOK/day* 66 rig-days = 224.4 million NOK.

At the time, the preliminary cost estimates for the complete upgrade at Valhall IP was as follows:

<u>Table 5:</u> Aker BP Valhall IP 2.0 Pre-study

Robotic Drilling System	kr 111 000 000
Control system	kr 50 000 000
Removal, prefabrication, documentation update	kr 20 000 000
Personnel (POB) and logistics	kr 83 000 000
Driller cabin	kr 10 000 000
Growth allowance (35%)	kr 96 000 000
Shaker upgrade	kr 20 000 000
Total	**kr 390 000 000**

Source: Aker BP, 2018; own creation

These cost estimates combined with the yearly savings corresponds to a payback period of 390 million NOK / 224.4 million NOK = 1.74 years for the complete upgrade.

According to the payback method, it is logical is to accept the Valhall IP upgrade project. However, due to the simplicity of the payback method, this method is not considered to be a suitable valuation approach for the project.

CHAPTER 8: SUMMARY, CONCLUSION AND RECOMMENDATIONS

The purpose of this thesis is to provide the most accurate valuation of Aker BP's investment in robotic drilling systems on the Valhall IP platform and conclude with a recommendation. Theoretically, investment decisions are based on the notion of future expected earnings, and the DCF model, provides a positive recommendation. The firm's return on investment rate is also supported by the CAPM, which indicates fair value. While it may be considered optimistic to believe that the payback method is a suitable valuation approach for such a complex project, it should still be considered as it provides a measure of the money at risk for the project. In addition to the valuation approaches, the Valhall IP upgrade has been shown to have synergistic effects with regards to the HSE focus and the improved quality control management system. These factors help to improve Aker BP's core values, as it strengthens the activities in the value chain.

In an overall assessment of the valuation approaches, most emphasis is placed on the DCF model because of the projects correlation with the valuation framework. As the model provides a positive recommendation, the thesis has a positive outlook for the investment in robotic drilling systems. Based on the estimates of several multiples in the calculation, it is considered appropriate to use an NPV range of 175-500 million NOK.

The DCF and NPV analysis indicates a profit of 237.748 million NOK and 420.647 million NOK for the 7 and 23 wells drilled on Valhall IP. This is considered to be a fair value of the project, and an investment in the Valhall IP upgrade is recommended as it increases the wealth of the company and its investors.

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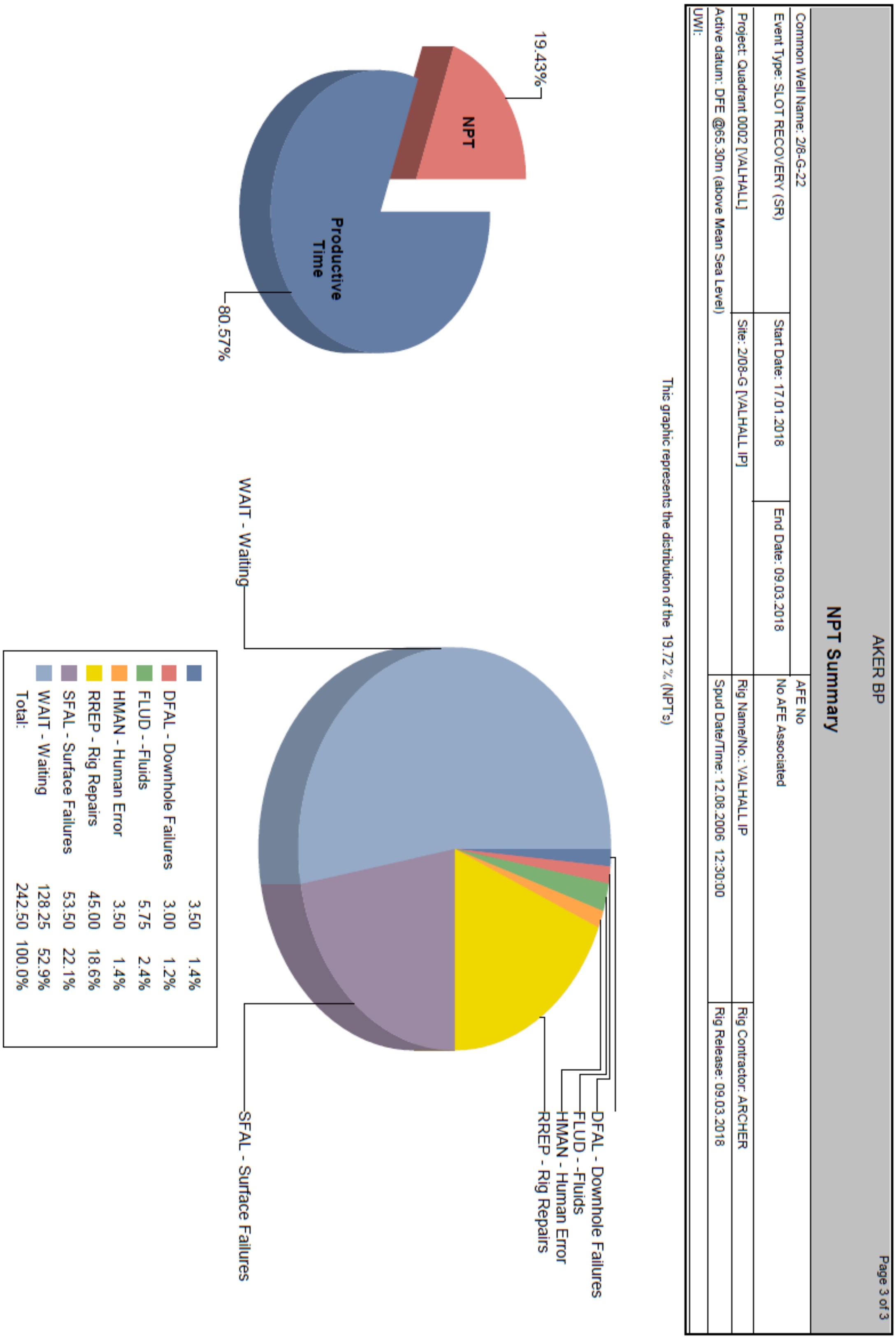
APPENDIX A: NPT SUMMARY 2/8-G-22



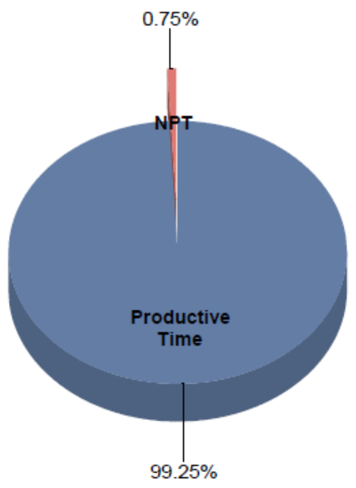
APPENDIX B: NPT SUMMARY 2/8-G-11

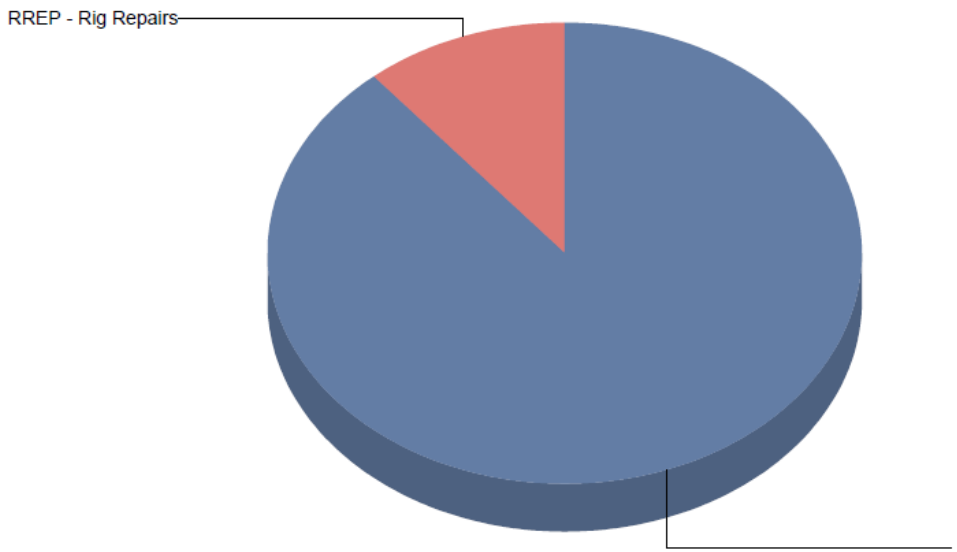
AKER BP

NPT Summary

Common Well Name: 2/8-G-11			AFE No	
Event Type: SLOT RECOVERY (SR)	Start Date: 01.06.2018	End Date: 02.09.2018	No AFE Associated	
Project: Quadrant 0002 [VALHALL]	Site: 2/08-G [VALHALL IP]		Rig Name/No.: VALHALL IP	Rig Contractor: ARCHER
Active datum: Platform DFE @65.30m (above Mean Sea Level)			Spud Date/Time: 04.02.2004 00:00:00	Rig Release: 03.09.2018
UWI:				

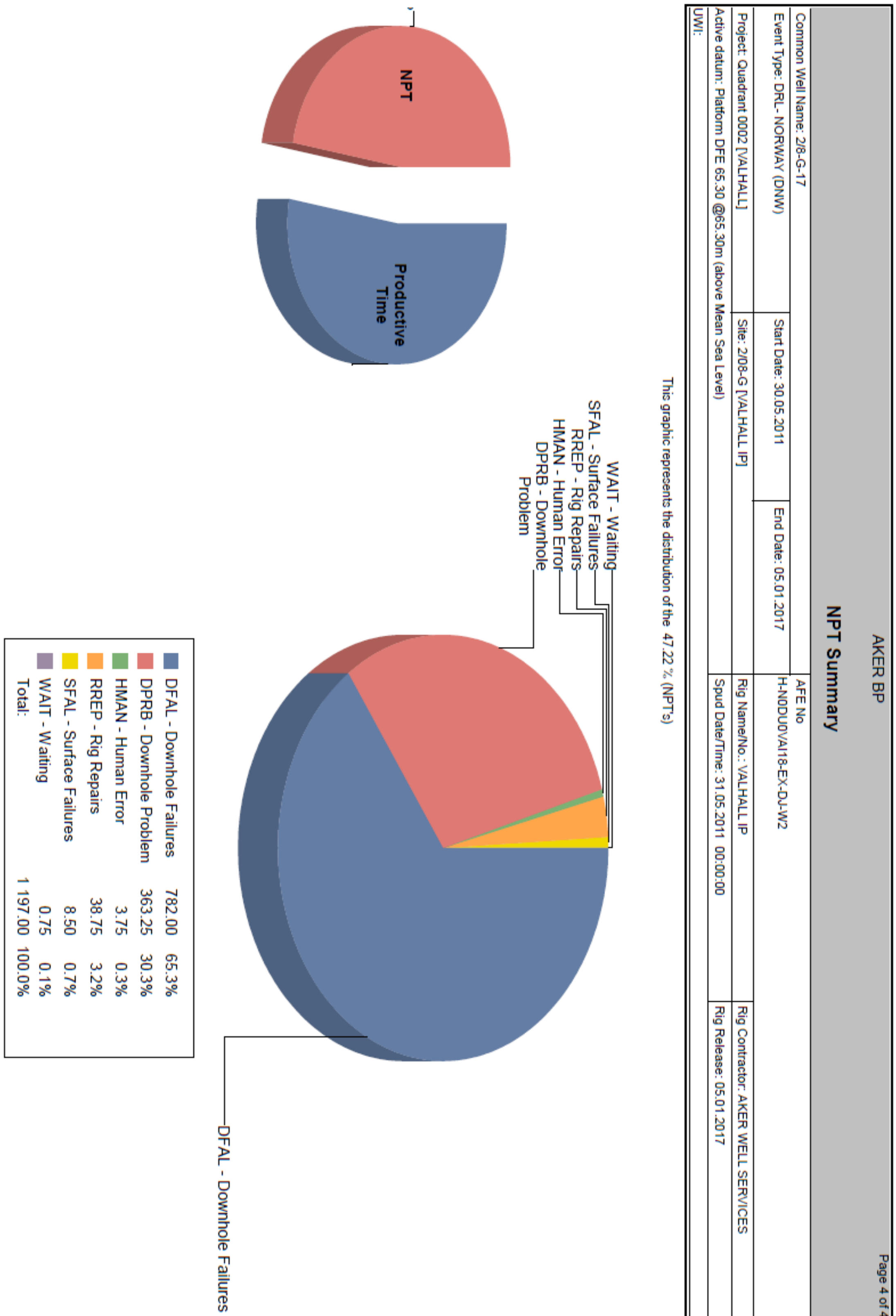
This graphic represents the distribution of the 6.77 % (NPT's)





	98.00	88.9%
RREP - Rig Repairs	12.25	11.1%
Total:	110.25	100.0%

APPENDIX C: NPT SUMMARY 2/8-G-17



APPENDIX D: NPT SUMMARY 2/8-G-20

AKER BP

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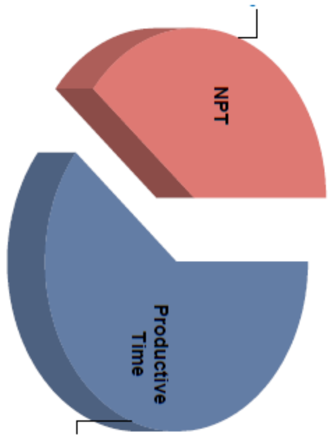
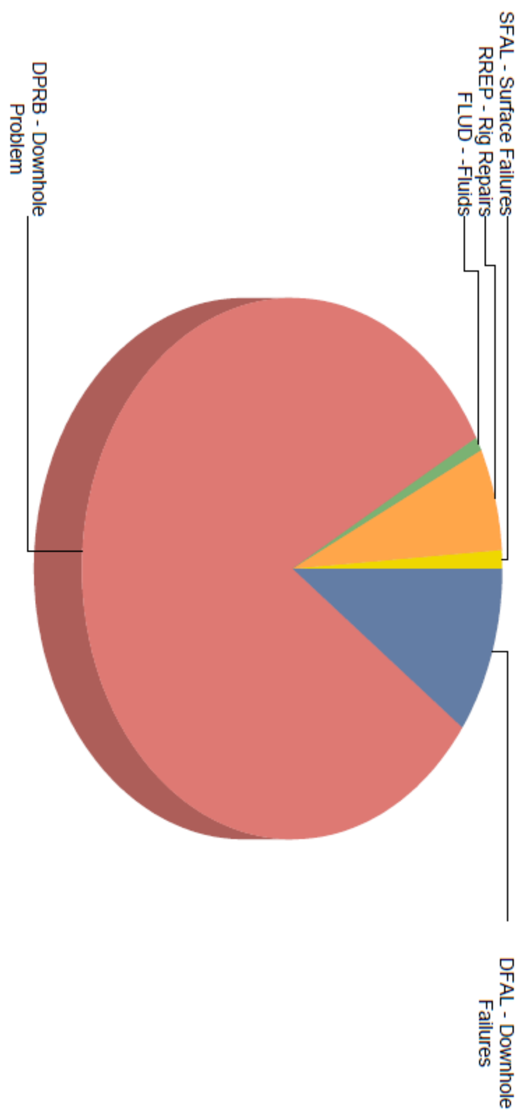
NPT Summary

Common Well Name: 2/8-G-20			AFE No	
Event Type: DRL- NORWAY (DNW)	Start Date: 10.06.2011	End Date: 03.09.2017	H-N0DU0VAI18-EX-D1-W2	
Project: Quadrant 0002 [VALHALL]	Site: 2/08-G [VALHALL IP]		Rig Name/No.: VALHALL IP	Rig Contractor: ARCHER
Active datum: Platform DFE 65.30 @65.30m (above Mean Sea Level)			Spud Date/Time: 10.06.2011 12:15:00	Rig Release: 09.06.2011
UWI: 2/8-G-20				

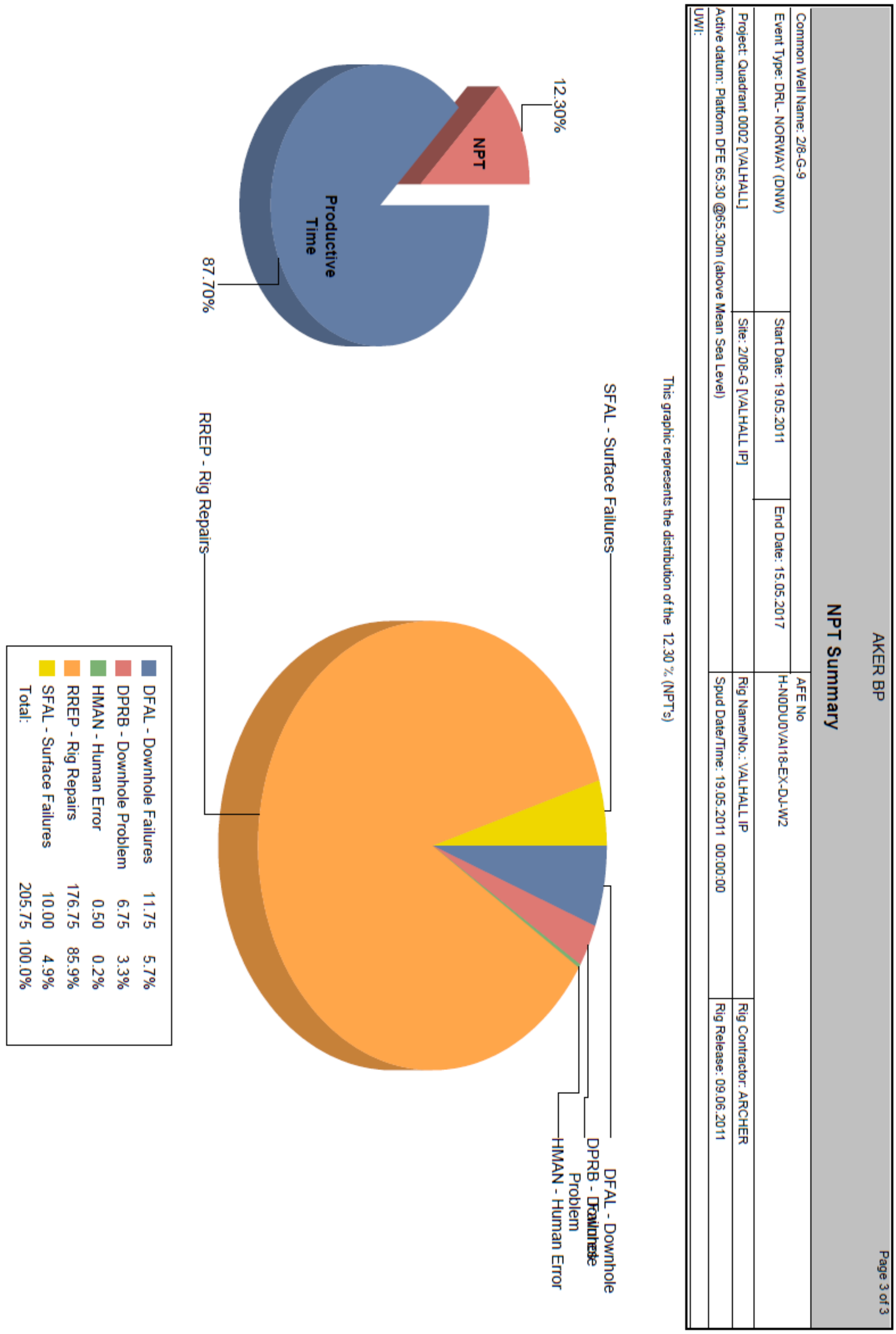
This graphic represents the distribution of the 38.94 % (NPT's)





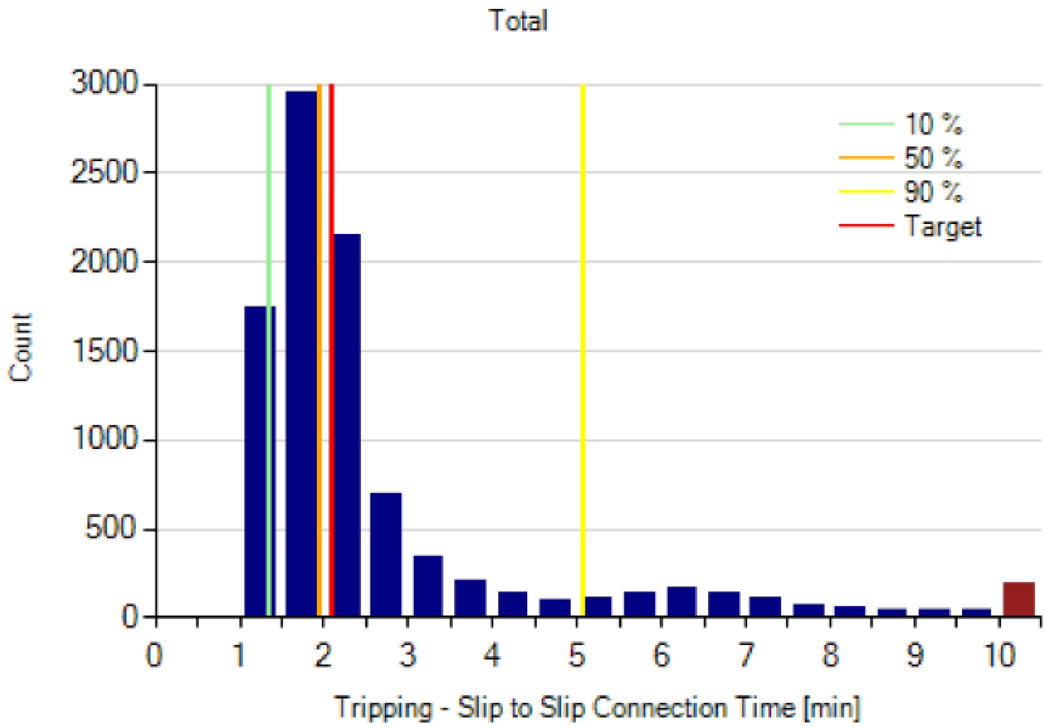
DFAL - Downhole Failures	92.50	10.0%
DPRB - Downhole Problem	760.00	82.1%
FLUD - -Fluids	6.00	0.6%
RREP - Rig Repairs	57.50	6.2%
SFAL - Surface Failures	10.00	1.1%
Total:	926.00	100.0%

APPENDIX E: NPT SUMMARY 2/8-G-09



APPENDIX F: TRIPPING SUMMARY G-11, G-17 AND G-22

Rig	Valhall
Wells	2/8-G-11 A, 2/8-G-11 T6, 2/8-G-17 T4, 2/8-G-22 A
Phase Diameters	20.00", 17.50", 16.00", 13.00", 12.25", 8.50", 6.50", No Diameter
Phase Types	Completion Phase, Hole Construction Phase, Plug and Abandon Phase
Run Types	Casing Run, Cementing Run, Conditioning Run, Drilling Run, Formation Treatment Run, Liner Run, Milling Run, Placing/Retrieving Equipment Run, Testing Run
KPI	Tripping - Slip to Slip Connection Time
Target	2.10 min



Crew Name	Total
Lower / Upper Cutoff	0.20 min / 10.00 min
Operation Count	9285
10 %	1.35 min
50 %	1.97 min
90 %	5.08 min
Average	2.54 min
Deviation Avg	1.67 min
Deviation Target	1.73 min
Total Duration	16 d 9 h 40 min
Savings Potential	4 d 12 h 56 min
Savings Potential [%]	27.67 %

APPENDIX G: DCF VALUATION OF AKER BP VALHALL IP 7 WELLS

Aker BP Valhall IP Upgrade 7 Wells Scenario

(NOK)	0	1	2	3	4	5	6	7	8	9	10
Investment costs	-826 000 000										
Valhall IP off- line costs	-408 000 000										
Increased Oil Productivity		0	0	203 797 800	0	0	0	0	0	0	0
Reduction of operational costs		224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000
Bank loan (9.39%)		-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400
Variable costs		-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000
Fixed costs		-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-52 500 000
Depreciation	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666					
Earnings before taxes (EBT)	-1 371 666 666	6 171 934	6 171 934	209 969 734	6 171 934	6 171 934	143 838 600	143 838 600	143 838 600	143 838 600	92 838 600
Total tax rate (78%)		-4 814 109	-4 814 109	-163 776 393	-4 814 109	-4 814 109	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-72 414 108
Earnings after tax (EAT)		1 357 825	1 357 825	46 193 341	1 357 825	1 357 825	31 644 492	31 644 492	31 644 492	31 644 492	20 424 492
Bank loan	826 000 000										
Depreciation	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666					
Total projected cash flows	-408 000 000	139 024 491	139 024 491	183 860 007	139 024 491	139 024 491	31 644 492	31 644 492	31 644 492	31 644 492	20 424 492
Present value	-408 000 000	126 385 901	114 896 274	138 136 745	94 955 598	86 323 271	17 862 491	16 238 628	14 762 389	13 420 354	7 874 526
Net present value	237 748 517										
Internal rate of return	Not Applicable										

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000
-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400
-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000
-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-52 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000
143 838 600	143 838 600	143 838 600	143 838 600	143 838 600	143 838 600	143 838 600	143 838 600	143 838 600	92 838 600	143 838 600	143 838 600	143 838 600	143 838 600	143 838 600
-112 194 108	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-72 414 108	-112 194 108	-112 194 108	-112 194 108	-112 194 108	-112 194 108
31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	20 424 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492
														-826 000 000
31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	31 644 492	20 424 492	31 644 492	31 644 492	31 644 492	31 644 492	-794 355 508
11 091 201	10 082 910	9 166 282	8 332 984	7 575 440	6 886 763	6 260 694	5 691 540	5 174 127	3 035 971	4 276 138	3 887 398	3 533 999	3 212 726	-73 315 835

APPENDIX H: DCF VALUATION OF AKER BP VALHALL IP 23 WELLS

Aker BP Valhall IP Upgrade 23 Wells Scenario

(NOK)	0	1	2	3	4	5	6	7	8	9	10
Investment costs	-826 000 000										
Valhall IP off- line costs	-408 000 000										
Increased Oil Productivity	0	0	0	326 076 400	264 937 100	509 494 400	203 797 800	142 658 400	40 759 600	20 379 800	20 379 800
Reduction of operational costs	0	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000
Bank loan (9.39%)		-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400
Variable costs		-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000
Fixed costs		-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-52 500 000
Depreciation	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666	-137 666 666					
Earnings before taxes (EBT)	-1 371 666 666	4 671 934	4 671 934	330 748 334	269 609 034	514 166 334	346 136 400	284 997 000	183 098 200	162 718 400	111 718 400
Total tax rate (78%)		-3 644 109	-3 644 109	-257 983 701	-210 295 047	-401 049 741	-269 986 392	-222 297 660	-142 816 596	-126 920 352	-87 140 352
Earnings after tax (EAT)		1 027 825	1 027 825	72 764 633	59 313 987	113 116 593	76 150 008	62 699 340	40 281 604	35 798 048	24 578 048
Bank loan	826 000 000										
Depreciation	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666	137 666 666					
Total projected cash flows	-408 000 000	138 694 491	138 694 491	210 431 299	196 980 653	250 783 259	76 150 008	62 699 340	40 281 604	35 798 048	24 578 048
Present value	-408 000 000	126 085 901	114 623 547	158 100 150	134 540 437	155 716 673	42 984 694	32 174 675	18 791 666	15 181 867	9 475 901
Net present value	420 647 058										
Internal rate of return	Not Applicable										

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
20 379 800	20 379 800	20 379 800	0	0	0	0	0	0	0	0	20 379 800	20 379 800	20 379 800	61 139 300
224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000	224 400 000
-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400	-77 561 400
-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000	-3 000 000
-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-52 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000	-1 500 000
162 718 400	162 718 400	162 718 400	142 338 600	142 338 600	142 338 600	142 338 600	142 338 600	142 338 600	91 338 600	142 338 600	162 718 400	162 718 400	162 718 400	203 477 900
-126 920 352	-126 920 352	-126 920 352	-111 024 108	-111 024 108	-111 024 108	-111 024 108	-111 024 108	-111 024 108	-71 244 108	-111 024 108	-126 920 352	-126 920 352	-126 920 352	-158 712 762
35 798 048	35 798 048	35 798 048	31 314 492	31 314 492	31 314 492	31 314 492	31 314 492	31 314 492	20 094 492	31 314 492	35 798 048	35 798 048	35 798 048	44 765 138
														-826 000 000
35 798 048	35 798 048	35 798 048	31 314 492	31 314 492	31 314 492	31 314 492	31 314 492	31 314 492	20 094 492	31 314 492	35 798 048	35 798 048	35 798 048	-781 234 862
12 546 997	11 406 361	10 369 419	8 246 084	7 496 440	6 814 946	6 195 405	5 632 187	5 120 170	2 986 918	4 231 545	4 397 646	3 997 860	3 634 418	-72 104 851

APPENDIX I: FORECASTED 7 WELLS PERFORMANCE

Aker BP Valhall IP - 7 Wells Performance						
Year	No upgrade: oil production GROSS mboepd	Upgrade: oil production GROSS mboepd	Difference in oil production GROSS mboepd	Total oil production (thousand barrels per year)	Total value (Million USD)	Total value (Million NOK)
2019	0,0	0,0	0,0	0,0	0,0	0,0
2020	1,9	1,4	-0,5	0,0	0,0	0,0
2021	3,0	2,8	-0,2	0,0	0,0	0,0
2022	4,7	5,7	1,0	365,0	23 725,0	203 797,8
2023	6,5	6,4	-0,1	0,0	0,0	0,0
2024	5,0	4,8	-0,2	0,0	0,0	0,0
2025	4,0	3,9	-0,1	0,0	0,0	0,0
2026	3,3	3,3	0,0	0,0	0,0	0,0
2027	2,9	2,9	0,0	0,0	0,0	0,0
2028	2,5	2,5	0,0	0,0	0,0	0,0
2029	2,3	2,2	-0,1	0,0	0,0	0,0
2030	2,0	2,0	0,0	0,0	0,0	0,0
2031	1,8	1,8	0,0	0,0	0,0	0,0
2032	1,6	1,6	0,0	0,0	0,0	0,0
2033	1,5	1,5	0,0	0,0	0,0	0,0
2034	1,4	1,4	0,0	0,0	0,0	0,0
2035	1,2	1,2	0,0	0,0	0,0	0,0
2036	1,1	1,1	0,0	0,0	0,0	0,0
2037	1,1	1,1	0,0	0,0	0,0	0,0
2038	1,0	1,0	0,0	0,0	0,0	0,0
2039	0,9	0,9	0,0	0,0	0,0	0,0
2040	0,9	0,9	0,0	0,0	0,0	0,0
2041	0,8	0,8	0,0	0,0	0,0	0,0
2042	0,8	0,8	0,0	0,0	0,0	0,0
2043	0,7	0,7	0,0	0,0	0,0	0,0
2044	0,6	0,6	0,0	0,0	0,0	0,0
2045	0,5	0,5	0,0	0,0	0,0	0,0

APPENDIX J: FORECASTED 23 WELLS PERFORMANCE

Aker BP Valhall IP - 23 Wells Performance						
Year	No Upgrade: Oil Production GROSS mboepd	Upgrade: Oil Production GROSS mboepd	Difference in oil production GROSS mboepd	Total oil production (thousand barrels per year)	Total value (Million USD)	Total value (Million NOK)
2019	0,0	0,0	0,0	0,0	0,0	0,0
2020	2,9	1,6	-1,3	0,0	0,0	0,0
2021	6,7	6,1	-0,5	0,0	0,0	0,0
2022	8,6	10,2	1,6	584,0	37 960,0	326 076,4
2023	13,2	14,5	1,3	474,5	30 842,5	264 937,1
2024	13,6	16,1	2,5	912,5	59 312,5	509 494,4
2025	14,6	15,6	1,0	365,0	23 725,0	203 797,8
2026	14,0	14,7	0,7	255,5	16 607,5	142 658,4
2027	12,9	13,1	0,2	73,0	4 745,0	40 759,6
2028	12,0	12,1	0,1	36,5	2 372,5	20 379,8
2029	11,1	11,2	0,1	36,5	2 372,5	20 379,8
2030	10,2	10,3	0,1	36,5	2 372,5	20 379,8
2031	10,5	10,6	0,1	36,5	2 372,5	20 379,8
2032	9,7	9,8	0,1	36,5	2 372,5	20 379,8
2033	9,4	9,4	0,0	0,0	0,0	0,0
2034	8,5	8,5	0,0	0,0	0,0	0,0
2035	7,6	7,6	0,0	0,0	0,0	0,0
2036	7,0	7,0	0,0	0,0	0,0	0,0
2037	7,4	7,3	-0,1	0,0	0,0	0,0
2038	6,7	6,7	0,0	0,0	0,0	0,0
2039	5,9	5,9	0,0	0,0	0,0	0,0
2040	5,4	5,4	0,0	0,0	0,0	0,0
2041	4,8	4,9	0,1	36,5	2 372,5	20 379,8
2042	4,5	4,5	0,0	0,0	0,0	0,0
2043	4,1	4,2	0,1	36,5	2 372,5	20 379,8
2044	3,8	3,9	0,1	36,5	2 372,5	20 379,8
2045	3,0	3,3	0,3	109,5	7 117,5	61 139,3