Investment Evaluation Tools for Industrial Projects

Net Present Value and Economic Value Added in Investment Analysis

Master's thesis

By

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ABSTRACT

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Companies are aiming for more productive and profitable projects in today's business world, since many companies' projects are funded by shareholders' money. Predicting a project's profitability in the future is inevitable in order to maximize profits and use the company's resources efficiently.

Project management is strongly linked to investment analysis. Choice of evaluation tool for investment analysis can have a broad impact on how well one predicts the profitability of a project.

The aim of this thesis is to analyse Net Present Value and Economic Value Added as investment evaluation tools for industrial projects. By applying these evaluation tools on the case studies provided by the case company (based on actual projects the company is contemplating on), further research on the benefits of these evaluation tools can be examined.

Keywords: Investment Analysis, Project Management, Cost Management

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I dag strävar företag efter mera produktiva och lönsamma projekt än förut, i och med att många företagsverksamheter är finansierade av investerare och aktieägare. Därför är det oerhört viktigt att förutspå projektens framtid med de bästa möjliga sätten för att maximera vinster och använda företagets resurser effektivt.

Projektstyrning är starkt länkat med investeringsanalys. Val av investeringsanalysverktyg för att evaluera dessa investeringar kan vara av stor betydelse för företagets framtid.

Syftet med denna avhandling var att analysera Net Present Value och Economic Value Added som evalueringsverktyg för industriella investeringar. Genom att tillämpa dessa evalueringsverktyg i fallstudierna som fallföretaget har erbjudit, är det möjligt att vidare forska i fördelarna med evalueringsverktygen.

Nyckelord: Investeringsanalys, Projektstyrning, Kostandshantering

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List of Abbreviations and Explanations

CapEx	Capital Expenditures
CFB	Circulating Fluidized Bed
CCG	Compact Cement Grinding
EBIT	Earnings Before Interest and Taxes
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EVA	Economic Value Added
ICP	Integrated Cement Plant
NOPAT	Net Operating Profit After Taxes
NPV	Net Present Value
OpEx	Operational Expenditures
WACC	Weighted Average cost of capital

1 Introduction

1.1 Purpose of Thesis - the Case Company

The case company is a leading company involved in the development of commercial utilization of oil shale and in manufacturing of infrastructure material. The case company's business consists of cement production and oil shale utilization for both power generation and cement clinker production.

The case company is contemplating on investing in various capital-intensive industrial projects, linked with oil shale projects and cement grinding plants with their energy supply solutions. The focus of this thesis is to evaluate these projects with the help of evaluation tools for investment analysis and to determine which one of the investment evaluation tools predicts the future of a project most successfully and measure a company's actual wealth because of the project. Furthermore, to fulfil the aim of the thesis, two case studies are analysed with two different evaluation tools in order to get an understanding of the actual profitability of the project's different scenarios and create a solution for the case company.

Other evaluation tools describe the project's profitability from a different point of view, which means that it defines profitability differently. Managers' decisions on whether to invest in a project or not can be influenced by several factors. The most important factor in any project is to make economic profit and use the company's resources feasibly. The case company has approximately 80 shareholders, hence making the economic profitability of each project even more significant. The following questions need answers, in order to reach the target of this thesis:

1. What investment evaluation tools are required to predict a project's profitability? Does the project's nature or timeframe make any difference in choosing which evaluation tool to use?

By answering these questions, one can determine how companies choose which investment evaluation tool to use for evaluating the project's profitability, since the implementation of these models contains subtle differences in how they interpret profitability. The project's nature may also have a role in deciding which evaluation tool to use.

2. What are these evaluation tools specifically missing, when describing a project's profitability?

For instance, there are evaluation tools that can tell an investor or manager whether a particular project is profitable, but does the evaluation tools give information about how profitable it is for an investor to invest in the project in comparison to the input he has given to the company? These statements are the fundamental pillars of this thesis, since productivity is one of the most important factors in today's business world.

3. How do these evaluation tools describe the increase of shareholder value?

This is a very important question for this thesis and concerns productivity as well. The investment evaluation tools used for analysis of the projects in this thesis are Net Present Value (NPV) and Economic Value Added (EVA), which are very different from each other, but have considerable advantages that are valuable for firms within the industry. The aim of this thesis is to theoretically investigate both evaluation tools and support the statements with empirical research done with the case company.

1.2 Research Approach

The research was done by reviewing theories of the evaluation tools for investment analysis and comparing these theories with each other and what they represent.

The empirical research in this study was based on two industrial projects provided by the case company. The main task was to make feasibility studies of the given projects and use these feasibility studies as case studies in the empirical research of this thesis. Both case studies were based on calculating the projects' profitability with different energy supply solutions. The aim of the empirical research was to use the financial models for investment analysis and determine the best solution for the case company. The aim of the thesis was to compare two different investment evaluation tools and determine which of these financial models predicts a project's future more successfully. Both advantages and disadvantages of the evaluation tools in question were considered when applying them to the case studies.

Every step in the case studies, such as production and business plan, was re-modelled in order to match the case company's reality in the future. The research was done by applying the action research approach.

2 Theory

2.1 Investment Analysis in Industrial Projects – Main Theory Areas

Two main theory areas are identified as relevant for the research. The chosen theories are Net Present Value applied from the DCF financial modelling, i.e. Discounted Cash Flow, and Economic Value Added, created by the management-consulting firm Stern Value Management, before known as Stern Stewart and Co (Worthington et al., 2001). Economic Value Added is a tool used for measuring a company's performance and is based on residual income.

These evaluation tools are suitable theories for analysing industrial investments and will be applied to the case studies in order to identify their advantages and disadvantages in industrial projects. There are two main types of criteria to measure a project's success, i.e. economic and technological criteria (Žižlavský O., 2014). However, this thesis will only analyse economic performances of industrial projects.

2.2 Net Present Value – NPV

Net present value, shortened NPV, is a measurement tool used by managers to measure an investment's profitability and guides managers to identify a project's financial value. NPV describes the time value of money; for instance, future money may have less value than current present value; a currency today may not have the same value tomorrow (Žižlavský O., 2014). NPV describes how profitable a project is for the company, taking into consideration the equity ratio of how the project is funded and the required rate of return of the invested capital, which is based on the discounted cash flows (Brealey A. et al., 2011).

NPV is a method used by companies and managers to determine whether a project is profitable or not. A project increases a company's wealth and shareholder value when the project's NPV is greater than zero. However, if the NPV is less than zero, the company will not experience a financial benefit from implementing this project; it will drain cash and result in loss for the company and shareholders. However, when the NPV is equal to zero, it does not benefit the company nor decrease the wealth of the company (Brealey A. et al., 2011).

Because of these statements, NPV has been an important tool for a manager's decision-making processes on whether to execute a project or not. The greater positive NPV, the more profitable it is to execute the project. A company with different investment alternatives compares them with one another by calculating the NPV and provides managers with an opportunity to analyse which alternative will be the most profitable choice in the future. The previous statement is one of the most beneficial aspects in this measurement tool. However, another important aspect when calculating NPV is to find the factors that affect the NPV results the most and to identify activities that turn cash flows positive faster (Copeland T.E. & Keenan P.T, 2005).

2.2.1 Present Value and Time Value of Money

When calculating NPV, defining the present values for every year of operation is the starting point of the calculation. Time value of money is considered as a complex concept for many individuals. They declare it as a concept of fiction, but it is an important concept in modern finance (Schmidt, 2018).

Time value of money has its origins in inflation and risk. As described earlier, the present value of a company today is not the same as the future value, on the contrary; the present value represents what the future value is worth today. If a fictional company has a positive cash flow of 100 000 € and receives the same amount of cash flow annually, the present value of future cash flows will be worth less today, for example 95 000 €, because of inflation and uncertainty (Schmidt, 2018).

Moreover, the present value is based on in- and out cash flows of the company. In order to obtain an accurate present value, all operational costs and activities that bring income for the company shall be included in the calculation of cash flow (Brealey A. et al., 2011).

$$PV = C1/ (1+r)^n \quad (1)$$

In this equation, C1 represents the cash flow from the first year of operation and is the difference between the present values of cash in- and outflows (Khan, 1999). The discount rate, most often used as WACC in the calculation, is described as r in the equation. n represents the number of periods. WACC, short for Weighted Average Cost of Capital, is a value describing how a project is funded (Brealey A. et al., 2011).

2.2.2 NPV equation

The NPV represents the sum of the present values of each year that is included in the calculations, subtracted by the initial investment cost (Khan, 1999):

$$NPV = \sum \{\text{Present value} / (1+r)^{n}\} - \text{Investment Cost} \quad (2)$$

The discount rate is presented as the letter *r* in the formula and *t* represents the length of the time period. The discounted cash flow is the same as present value and is calculated by using the discount rate. The discount rate is company specific, since it describes how a certain project is funded and is an important factor when it comes to calculating the NPV of a company, since the higher the discount rate, the lower present values of future cash flows will be obtained by the company (Khan, 1999).

2.2.3 Discount rate - Weighted Average Cost of Capital

There are several different ways of calculating the discount rate, but the most common way is using the WACC. The WACC of a certain project describes how the project is funded. Furthermore, in order to calculate the WACC, cost of equity, cost of debt and percentages of equity and debt ought to be known (Brealey A. et al., 2011). The formula for calculating the WACC is presented in the equation below:

$$WACC = (E/V) * Re + (D/V) * Rd * (1-T) \quad (3)$$

E is for equity and *D* is for debt, while *V* represents the sum of equity and debt, making *E/V* the percentage of equity and *D/V* the percentage of debt. *Re* and *Rd* are the cost of equity and debt, respectively. *T* represents the corporate tax rate, which is included in the calculation of the WACC (Brealey A. et al., 2011).

2.2.4 Advantages and disadvantages in the NPV approach

One of the main advantages in the NPV approach is that it describes the time value of money, since it is a component of DCF financial modelling. Furthermore, NPV considers cost of capital and risk, which helps both managers and investors to acquire information on whether the project is profitable in the future or not. Accordingly, NPV explains whether the company becomes wealthier because of the project or whether it results in draining cash from the company (Brealey A. et al., 2011). The NPV approach answers this question, but there are quite a few other perspectives to consider.

NPV is not an end-all solution, since it does not consider productivity. For instance, if company A has the same NPV for a particular project as company B, but company B has invested far less capital in order to achieve the same NPV as company A, it is not as profitable as company B's project, considering the productivity of the project. Comparing two different projects of different sizes is not the strength in the NPV approach, since NPV measures output only, instead of considering the ratio between capital invested in the project versus profit (Schmidt, 2018).

When an investor is looking at the NPV results, obtaining information of the firm's cost of capital requires guessing. However, NPV is very useful when it comes to comparing different scenarios for the same investment or similar industrial investments from different suppliers (Schmidt, 2018).

The NPV approach discounts cash flows with a constant discount rate, which is the same as assuming that no changes or managerial decisions will be made during the period of the project (Copeland T.E. & Keenan P.T, 2005). Thus, NPV results may arouse uncertainty of how profitable the project is, since expenses that are not of economic value for the company are embedded in NPV. However, future decisions and events that affect the NPV of the project are difficult to predict with desired confidence, despite the choice of evaluation tool.

2.3 Economic Value Added – EVA

Since companies are receive an increased pressure on delivering shareholder value, managers seek to maximize the wealth of shareholders by effective use of recourses and predicting the company's future financial performance. The usual concept of a company's main goal is maximizing profit, which does not necessarily mean book profit, which has non-cash expenses embedded, but maximizing economic profit. Increasing wealth of the company and shareholders becomes more and more important for companies funded by shareholders' money and this is why economic value added has evolved into an established tool in the business world (Kislingerová E., 2000).

EVA, Economic Value Added, is a new concept that measures a company's wealth and business performance. The strategy consultancy company Stern Stewart & Co. has developed the concept of EVA and since creating shareholder value is an important factor for firms now, EVA is an effective tool to describe the realistic and true economic profit of a firm (Worthington and West, 2001). Like NPV calculations, when the company obtains a positive EVA, the project is regarded to be profitable. In contrast, negative EVA results in decreasing the wealth of shareholders and the company (Kislingerová E., 2000).

2.3.1 Calculating EVA

There are several different ways for a company or manager to apply EVA on a project or business. One of the more traditional ways is to base the calculations on the statement that economic profit depends on equity, cost of equity and the return on equity. Nevertheless, another way of calculating EVA is to focus on the important operational activities that create value for the company and further increase the shareholder value (Salaga J. et al., 2015). In this study, the calculation procedure of EVA will be based on the following formula:

$$EVA = NOPAT - WACC * C \quad (4)$$

NOPAT, short for "Net Operating Profit After Taxes", is the true profit a company obtains during a year, since excluding depreciation and amortization, tax expenses and interest expenses from NOPAT differentiates it from EBIT or EBITDA for example. In the formula, one can see that companies that are gaining high NOPAT with minimum capital will obtain a higher value added from their operations (Salaga J. et al., 2015).

NOPAT is derived from EBITDA, i.e. Earnings Before Interest, Taxes, Depreciation and Amortization, which means that when these expenses are excluded from EBITDA it will equal the company's NOPAT (Kislingerová E., 2000). NOPAT is often calculated from EBIT, i.e. Earnings Before Interst and Taxes, which is practically the same thing as EBITDA with depreciation and amortization of investments and loans excluded (Salaga J. et al., 2015). In equation 5, the formula for the latter statement is introduced.

$$EVA = EBIT * (1-t) - WACC * C = NOPAT - WACC * C \quad (5)$$

EVA is the difference between NOPAT and the capital charge used for achieving the value of NOPAT. The capital cost multiplied with WACC equals the capital charge. NOPAT is regarded to describe the true profit of a company more than EBIT or

EBITDA because of including the after-tax effect, which thereby separates operational activities from financing activities, making EVA one of the most established tools for measuring a company's financial performance (Worthington, 2001).

C represents long-term capital and is the sum of equity and invested capital. WACC is company specific and used as discount rate in several different economic measurement tools, in order to transfer future values of EVA or NPV to present values of the current date's valuation (Kislingerová E., 2000). In Figure 1, the underlying concept of EVA is introduced.

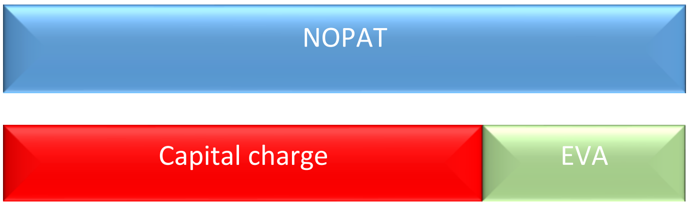


Figure 1. The EVA approach.

As illustrated in Figure 1, the capital charge is the amount of money the shareholder invested. When the capital charge is subtracted from NOPAT, one can clearly see value added in the process. This is what shareholders and investors want to see; how much return will they receive from this project. The value-added represents the profit they will receive from investing a certain amount of capital in the project.

Nevertheless, there are three fundamental steps in the calculation of EVA. Firstly, in order to indicate a company's performance, the company's cash flow is one of the most important factors. Furthermore, converting the EBIT of a company's business operations to cash-based net operating profit, i.e. NOPAT, is inevitable for acquiring a reasonable EVA, since otherwise it does not represent the true profit that the firm will obtain (Salaga J. et al., 2015).

Secondly, expenses that are based on investments should be capitalized in the balance sheet in order to acquire the true profit of a firm and that is why a capital charge is calculated. Therefore, capitalized expenses are excluded from NOPAT in order to obtain an actual profit from the firm's operations, which simply means that taxes, interests, depreciation and amortization ought to be excluded from cash flows as well (Investopedia (3), 2018).

Thirdly, expenses for equity capital are accounted for and it is done by deducting a capital charge for the invested capital. By knowing the WACC of the project, one can demonstrate to shareholders how much they can expect in return and how big a risk or level of uncertainty there is in this project.

Furthermore, considering time value of money in the EVA approach, the NOPAT is discounted with the WACC in order to describe how much the future values are worth today. The WACC used in the capital charge does not discount the cash flows, however, discounting NOPAT is required in order to be able to predict a project's future cash flows (Kislingerová E., 2000).

2.3.2 GAAP adjustments

There are approximately 160 different GAAP-related accounting adjustments involved in the EVA calculations, i.e. generally accepted accounting principles. The adjustments are made in the calculation of NOPAT. Nevertheless, only a few adjustments take place, since it is company specific and dependent on the company's operation and business, usually based on both empirical and theoretical concerns (Andrew C. Worthington, 2001). Some actions may increase a manager's earnings but may destroy value, while some other actions may do the opposite. That is why the GAAP adjustments are important in order to describe the reality of the company's true profit (Worthington, 2001).

The reason for applying these adjustments in the EVA-calculations is to bring the financial modelling closer to reality, since reported earnings do not tell the whole truth of the company's profits but, at times, these GAAP adjustments are used to make the appearance of a project or a company more lucrative for potential investors. For instance, a great example is to determine the difference between tangible and intangible assets. Tangible assets are capitalized, while intangible assets are most often written off the balance sheet. Other examples are write-off of goodwill that arises when a company buys another company for a higher market price and does not include that additional money as profit (Worthington, 2001).

Even though there are up to 160 different GAAP adjustments, companies using Stern Stewarts EVA financial management system are only applying from ten to fifteen GAAP adjustments in their EVA calculation, since most of the GAAP-based adjustments proposed may have no impact on the company's profits (Worthington, 2001).

The methodology of Economic Value Added and the GAAP adjustments is to apply the adjustments that bring a significant change in the company's profits. For instance, there are successful and unsuccessful investments, where usually the unsuccessful investments are written-off, while shareholders are interested in seeing all the investments. GAAP adjustments on the NOPAT will make investors more tempted to be a shareholder in the company, since the EVA results will look more lucrative. An appropriate example is when an oil company is exploring oil deposits and drilling holes. They might have drilled quite a few holes before they found the oil deposit, but the total expenses of the drills are most often excluded (Worthington, 2001). Another example is, for instance, selling land. The company owns land and sells the land for a considerable price. Even though the company will obtain cash from the land sale, it is not directly profit, since it is not an operation in the company's business. In this study, GAAP adjustments will not be applied in the empirical part of the thesis, since it is company specific and may contain confidential information. However, GAAP adjustments are mentioned in the thesis for examining the advantages and disadvantages of the performance metric. Most often, managers are using these GAAP adjustments for artificially enhancing and improving the EVA results, giving shareholders something more lucrative in front of them to observe.

2.3.3.1 The significance of capital charge

An important step in the EVA approach is the capital charge. The capital charge is not as simple to calculate as many assume. The sum of liabilities and shareholders' equity equals the total assets in a balance sheet. The controversial aspect in this statement is that there are plenty of items in the balance sheet that should not be included in the calculation of cost of capital when calculating the economic profit of a firm, since they are not provided by shareholders. If the aim is to increase shareholder value, only one's own equity and capital provided by shareholders should be considered when calculating economic value added (Investopedia (4), 2018).

For instance, suppliers do not lend money to the company and to assume that it is invested capital will result in giving false results. Taxes payable have the same nature in this context since it is not excluded from the calculation of cost of capital. The state is neither loaning nor investing in the company, which practically means that it should be excluded from the calculation of cost of capital. It is most often still included (Investopedia (4), 2018).

However, there is much involved in the EVA calculation. For instance, risk is an important element in any economic measurement tool and is highly considered by investors. In order to understand the economic impact of the capital charge in the EVA calculation, consider that a business has three fundamental aspects that are considered by investors. When an investor considers investing in a company, the investor will consider assets, profit and risk. NOPAT deals with a company's profit, while capital charge deals with a company's assets, including a risk element as well (Kislingerová E., 2000).

Consider an investor providing a certain amount of capital/assets to the company, but he/she is uncertain about the level of profit they will be receiving after a certain period (Investopedia (4), 2018). The WACC represents risk, while cost of capital is the total invested capital in the company. WACC multiplied with cost of capital will represent investors' capital that is at risk. Accordingly, when EVA is close to zero, it means that the company has been able to pay back the investors' invested capital, while the company increases shareholder value when the EVA is greater than zero, which means that the shareholders receive some sort of profit, thereby an increase of shareholder value has occurred (Kislingerová E., 2000).

Furthermore, this is the main reason why EVA is used for measuring shareholder value, since an investor can identify the productivity of the business, i.e. in- and output scenario of the business. The input for an investor is the capital invested in a company, while the output is the received profit. The investors have resources to their disposal that they invest into a company for an expected return. EVA is a tool specifically used for making these financial decisions (Investopedia (4), 2018).

2.3.3.2 Economic spread and productivity

Productivity, often linked with shareholder value, is easily observable in the EVA approach. As stated earlier, the common equation for calculating the EVA of a company or project is using the NOPAT and subtracting it with the capital charge (Worthington, 20199).

$$EVA = NOPAT – C*WACC \quad (6)$$

Since NOPAT is considered as the net profit of a firm, it equals ROIC, i.e. Return on Invested Capital, multiplied with invested capital.

$$NOPAT = ROIC*C \quad (7)$$

By inserting equation (2) into the traditional EVA equation, it is possible to obtain an equation that describes shareholder value precisely (Investopedia (4), 2018).

$$EVA = (ROIC – WACC) *C \quad (8)$$

According to the EVA approach, companies that are performing well have low percentages on WACC and higher percentages on ROIC when obtaining higher EVA. However, ROIC subtracted with WACC is called the economic spread. Economic spread is the factor describing productivity and the increase of shareholder value (Investopedia (4), 2018).

As stated earlier, WACC represents the risk and capital invested from the investor's point of view, while ROIC is the expected return on the capital invested in the project (Salaga J. et al., 2015). In other words, if the economic spread equals zero, the company has not increased nor decreased shareholder value, but the company has been able to pay back the shareholders. However, a positive economic spread represents how much shareholder value created because of the project in per cent, while negative economic spread means that the project will decrease shareholder value.

2.3.4 Advantages and Disadvantages

EVA is one of the most reliable measurement tools of managerial skills in a company. EVA gives a better understanding of what a manager should do in order to decrease the cost of capital for a larger capital-profit ratio. By using EVA, a company can acquire information about which section in the company's operations has ineffective capital, meaning capital that is not efficiently contributing profit to the firm. By calculating the EVA of every segment in the company's operations, it is possible to determine which sector of the business operations needs improvements (Investopedia (4), 2018).

By looking at the EVA of a firm, project or activity, it is possible to know how much one can expect in return. EVA is a true definition of productivity; how much can one expect in return for one dollar. If EVA is close to zero, the shareholders' debt is paid, but when EVA is positive it is greater than the debt, the shareholders receive profit. That is why EVA is most often linked with analysis of how a certain project will affect the shareholder value in the firm. By calculating the EVA, it is possible to know how a certain project will increase or decrease the shareholder value of the firm.

The EVA approach can be easy to understand, since the equation is quite simple. However, applying the EVA calculation can be more difficult than anticipated, due to all certain factors that must be excluded from the earnings in order to obtain the annual NOPAT. Furthermore, GAAP adjustments make the application of EVA more complicated, since GAAP adjustments are company specific and used for making the EVA results look better as well. Calculating the true cost of capital may also be rather complicated. In order to acquire good results on EVA, it is more than important to have all these factors well calculated (Investopedia (3), 2018).

NOPAT represents the measure of profit with other financing costs and taxes excluded, while the capital charge represents the capital invested in order to obtain the achieved NOPAT. EVA tells more than just how well a company is performing; it is a measure of how well a certain project creates economic profit, while satisfying shareholders at the same time, since the capital charge is a product of total cost of capital multiplied with the WACC. The capital charge represents how much capital the shareholders have invested in the project, leading to the fact that EVA is the true profit that the shareholders can expect in return (Investopedia (4), 2018). That is why EVA brings quite a few advantages when it comes to evaluating a project and firm.

3 Methodology

3.1 Action Research

In 1946, Kurt Lewin introduced the methodology of action research when he was studying changing environments in social systems (Susman, G.I. & Evered, R.D., 1978). The action research approach is defined as a systematic methodology in finding solutions for various problems. The formulated problems can be based on organizational, educational or social issues. Furthermore, action research, linked with changing environments and collecting data for interpretation, consists of a researcher or a consultant collaborating with an organization in order to solve a specific problem. At first, action research aimed to provide solutions for practical problems in social sciences, while today action research has expanded its area of application and can be applied to organizational and business processes as well (Susman, G.I. & Evered, R.D., 1978).

Action research can be divided into three different categories. Firstly, the positivist approach that is based on social experiment. Secondly, interpretive action research, which consists of activities that are based on organizational or local factors. Thirdly, critical action research, which is based on improving business processes with a critical approach. The empirical research of this study is based on the critical action research (Bryman A. & Bell E., 2011).

In order to apply action research on any kind of study concerning organizational or business issues, the possibility to improve a process must be present. Generally, the first step of action research is data gathering for further evaluation and analysis. By collecting data, an approximate description of a problem's reality can be formed for further observation (Susman, G.I. & Evered, R.D., 1978). The fundamental steps in applying action research on any study is illustrated in Figure 2.

Figure 2. Stepwise illustration of action research.

The five steps illustrated above are necessary to apply on a case in order to obtain a comprehensive solution for a problem. Nonetheless, all research is unique and may therefore differ in the number of steps used when executing the action research approach. The reason for fewer phases may be that the researcher or consultant uses information that is provided by the client, who already has undertaken the first necessary steps in the action research process, for instance using another technique for collecting data, which makes the researcher's work narrower (Susman, G.I. & Evered, R.D., 1978).

The first step is defining the underlying problem. The second step, called action planning, consists of activities where the researcher investigates various solutions available for solving the problem. In the third step, called action taking, the researcher will select a solution that will overall create most value for the client. The fourth step consists of studying the consequences the solution will bring. In order to acquire information about the solutions and determine which solution creates most value, they are compared to each other already in the action planning stage. In the fifth step of action research, the advantages and disadvantages of the solution are identified and further evaluated (Susman, G.I. & Evered, R.D., 1978).

3.2 Application of action research to case studies

The action research approach was used in the case studies that consisted of two pre-feasibility studies of two different kinds of industrial projects. The first stage of the action research approach, **problem formulation**, consisted of creating energy supply solutions for the case company's industrial facilities and to analyse the projects' profitability. The case company provided internal information about project activities and the information given was further assessed to describe the reality of the projects. Analysing the technical processes of the projects was essential for creating economic values for the in- and outflows in the industrial complex.

In the second step, **action planning**, the scope of the research is planned. Investment evaluation tools are chosen, and manager interviews are taken. Two different types of investment evaluation tools have been considered as possible solutions for analysing the investments' profitability, i.e. Net Present Value and Economic Value Added. The action planning stage consists of reviewing the investment evaluation tools for further observations.

The third step of action research, **action taking**, consisted of data gathering and energy balance calculations. The estimated energy outputs were converted to an estimated future cash flow. The operational expenditures of the projects were provided by the case company as variable & fixed Costs (including S, G & A costs) of each project. Furthermore, the operational expenditures were added to a cash flow statement without electricity costs, since it was a task concerning energy supply solutions for the project and the cost of electricity varies depending on the scenario chosen. The case company gave information about project cost, sales, cost of sales, EBITDA, EBITDA margin, equity ratio and cost of capital, but this information was re-calculated and adjusted in order to describe the reality of the operations during the coming years, by specifically re-modelling the breakdown structure of the variable costs and activities that contribute to income.

In **action taking**, one evaluation tool will be chosen to analyse these industrial projects. Net Present Value was at first chosen to evaluate the projects' profitability. The action-taking step is re-visited after the NPV analysis, where EVA is chosen as investment evaluation tool. Furthermore, two managers in the company's top management are interviewed in order to bring practical insight on the issue. The managers take part of the company's decision making in business operations and large investments.

In the fourth step of action research, **evaluation**, the results for the investments' profitability are further examined. How well did the evaluation tool describe the projects' profitability and how can the results promote decision making in industrial investments? What are the advantages and disadvantages of the evaluation tools? These questions will be further evaluated in this thesis.

In the last step of action research, **specify learning**, the advantages and disadvantages of the evaluation tool will be reviewed in order to answer the questions that were presented at the beginning of the thesis. The specify learning stage of the research includes a summary of all the findings. In order to compare NPV with EVA the action research approach was repeated from the third stage, **action taking**, where EVA was chosen as an evaluation tool to analyse the projects' profitability.

The case company introduced two different projects; a wind power investment that will supply energy for two cement grinder plants, and cement clinker factory investment that uses oil shale ash as raw material for different purposes. The latter project has one business case pain, which concludes determining the thermal energy demand in the integrated cement plants' furnace and cover the thermal energy needs. These projects were used as case studies in the thesis, in order to evaluate NPV and EVA as evaluation tools for industrial projects. Moreover, the projects are very suitable as case studies, since the first one is a smaller project, while the other one is a capital-intensive project, which makes it relevant for comparing NPV and EVA as evaluation tools, since projects of different sizes have to be considered as well.

4 Empirical Research – Case Studies

In this chapter, the case studies will be presented with their various energy supply scenarios. The NPV and EVA results of both case studies are introduced, and the most profitable energy supply solution will be presented, but without any significant role in this thesis, since the target is to gain a better understanding of how NPV and EVA work as evaluation tools. Using NPV and EVA as investment evaluation tools in the case studies was the main target of the empirical research. NPV and EVA analysis were executed in order to be able to compare these tools to each other and find out what specific information these evaluation tools are giving, since both tools measure performance and profitability, but may tell a manager or shareholder different things. The evaluation tools have been used in the case studies for comparing the project scenarios to each other and later creating an energy supply solution for the case company. In this thesis, the main target is to find out how NPV and EVA describe the profitability of a project and what the evaluation tools lack.

4.1 Case study 1 – Continuous Energy Supply for a Facility Consisting of Two Cement Grinder Plants

4.1.1 Problem formulation

The case company's business consists of cement production for the construction and infrastructure markets. The case company has invested in a cement grinder plant suitable for large cement production. Due to ambitious investments made in the infrastructure sector and high demand of infrastructure material in the location, the markets for cement business is highly profitable in the area. Thus, the case company is considering a second cement grinder plant in order to enlarge the annual production.

The first plant has an electricity supply contract from the network owned by a state utility; however, the capacity of a second plant would require a larger energy supply in comparison to what is available. Currently, the first cement-grinding unit has a peak power input of 3000 kW in order to operate, but the continuous consumption of electricity is approximately 1700 kW. Adding a second cement-grinding unit to operation would result in higher power input and electricity consumption as well; with an input power of 5500 kW and continuous power consumption of 3300 kW, respectively.

The case company is aiming for an uninterrupted 24-hour-a-day operation of the cement-grinding plants, which makes the electricity needs even more significant. The location, known to have one of the largest solar power plants in the world and large wind power plants as well, has high potential in terms of renewable energy production. Furthermore, the renewable energy concept has turned extremely competitive in comparison to the traditional energy technologies, since expensive fuel import to the area of operation and environmental impact make the difference between the two alternatives.

Conveniently, a construction permit of a wind power capacity is automatically available in these types of situations, hence creating new energy supply alternatives for the case company. The objective of this study is to determine the most beneficial energy supply alternative for the cement grinder plants and optimize a solution that will have the best economic impact on the firm's overall performance. Investigating the evaluation tools' tendency to describe how shareholder value is increased or decreased is the main one.

4.1.2 Action planning – Energy supply scenarios and choice of evaluation tool

Case study 1 has quite a few different energy supply options. The energy supply scenarios were based on two different sources, i.e. purchasing electricity from the state utility of energy or investing in wind power, or a combination of these. However, the main question in case study 1 is whether it makes sense to invest in wind power instead of purchasing electricity from the state utility, and furthermore, which one of these combinations turns out to be the most lucrative choice.

One cement-grinding unit has the capacity of 3 megawatts, which means that two cement-grinding units' capacity is 6 megawatts. In addition, the wind power scenarios consist of new turbines and second-hand turbines as well. Wind power is a renewable energy technology that utilizes kinetic energy in the wind to generate electricity, which means that it does not generate the same amounts of electricity continuously. The capacities for every scenario in Table 1 represent the amount of capacity covered by the wind power investment.

Energy supply alternative	**State utility**	**Wind Power**	**Description**
Scenario A	6 MW		The electricity demand of the cement grinding units met with purchasing the total amount of needed electricity from the state utility nearby.
Scenario B	3 MW	3 MW	The wind power investment will be large enough to cover the electricity needs for one unit. The other unit's electricity needs covered by purchased electricity from the state utility.
Scenario C		6 MW	The electricity needs covered fully by wind power.
Scenario D	3 MW	3 MW	Similarly, to scenario B, wind power covers the electricity needs of one unit. In this scenario, second-hand wind turbines are purchased.
Scenario E		6 MW	Second-hand wind turbines will cover the total amount of needed electricity.
Scenario F		6 MW	The total amount of needed electricity covered by wind power but purchased in a period of three years. One third of the wind turbines are purchased every year, meaning that this scenario is identical to scenario C, but the turbines are purchased in a different order.

Table 1. Energy supply alternatives for the cement grinding units.

Scenario A is the only energy supply option that does not include any wind power investment, while all the other scenarios are either combinations of purchasing electricity and wind power investments, or energy supply fully covered by wind power.

In the action planning stage, two evaluation tools are reviewed to analyse the project's profitability, i.e. Net Present Value and Economic Value Added.

4.1.3 Action taking in case study 1 – Net Present Value

NPV was chosen as evaluation tool to analyse the wind power project's profitability. The data gathering in case study 1 was extensive, since optimizing the energy supply solutions and their economic impact on the project required several analyses. The optimization of the energy supply solutions consisted of calculating the annual electricity production of the wind farm scenarios in megawatt-hours and optimizing how many hours a day the wind turbines are not supplying enough electricity for the cement-grinding plants. By proceeding with a wind analysis, it was possible to determine whether the wind farm is generating enough electricity to meet the electricity demand of the cement grinder plants and to determine how much back-up electricity can be purchased from the state utility of energy, and furthermore, how much excess electricity is generated to be sold to the grid.

The wind analysis estimated the wind velocity at the hub height for every three hours during a day and how much electricity the wind farm would generate at the hub height wind velocity. The power generation for every three-hour period was calculated in order to determine whether the wind farm generates enough electricity or not. When the wind farm is not generating enough electricity, the needed back-up electricity for every three-hour period is calculated by equation (9) below. Furthermore, the amount of back-up electricity of every three-hour period during the whole year is summed up in order to obtain an annual value of back-up electricity that can be used for financial evaluation of the project.

$$E_{back\text{-}up} = E_{required} - E_{generated} \tag{9}$$

Nevertheless, since wind power is dependent on wind velocities it may at times generate far more electricity than needed. The amount of excess electricity is also calculated by the same method as back-up electricity, which means that the excess electricity of every three-hour-long period is summed up together in order to acquire an annual value for excess electricity. The amount of excess electricity is calculated by the equation below.

$$E_{excess} = E_{generated} - E_{required} \quad (10)$$

Thus, purchasing back-up electricity has the same price as the usual electricity tariff in this study, while the price of sold electricity per megawatt-hour is one third of the general tariff in the area.

The capital cost of the wind farm scenarios was estimated by a €/MW methodology from Wind Energy – The Facts (Wind Energy – The Facts, 2006). In Table 2, the project cost breakdown structure of a regular wind farm project is presented with its estimated values per megawatt unit. The capital cost of a wind farm can be divided into three branches, i.e. turbines' capital cost, balance of system and financing costs. These branches are further divided into specified categories of what the capital costs of a wind farm consists of, which can be seen in Table 2.

Capital Expenditures	**€/MW**
Turbines' capital cost	**650 000**
Assembly and Installation	20 000
Site Evaluation and Foundation	90 000
Control Systems	4 000
Electrical Infrastructure	110 000
Balance of System	**224 000**
Insurance	2 850
Contingency	7 600
Construction Financing Cost	8 550
Financial Costs	**19 000**
Total Capital Cost	**893 000**

Table 2. Estimation values used for calculating the capital cost of the wind farm scenarios.

The operational expenditures of the wind farm were calculated with the help of an MWh-method from Wind Energy – The Facts (Wind Energy – The Facts, 2006). By obtaining a value of the annually generated electricity of the wind farm scenarios from the energy optimization executed earlier, it is possible to estimate the operational expenditures of the wind farm with the €/MWh values presented in Table 3, which includes an illustration of the breakdown structure of operational expenditures in a regular wind farm investment.

Operational Expenditures	**€/MWh**
Insurance	1,68
Long-term service agreement	3,36
Land Lease	1,68
Monitoring	1,68
Operation	**8,4**
Scheduled Maintenance	2,8
Unscheduled Maintenance	2,8
Maintenance	**5,6**
Total Cost of Operational Expenditures	**14**

Table 3. Estimation values for calculation of operational expenditures in the wind farm scenarios.

The financial modelling of the cash flow sheet was estimated in order to meet the reality of the business operations. There were quite a few variable costs depending on the annually produced cement. Various variable costs were adjusted by the equation below in order to meet the actual costs for producing a certain amount of cement.

$$\text{Variable costs} = \text{Production}_{\text{cement}} * \text{Price}_{\text{variable costs}} \quad (11)$$

Every type of variable cost in the project adjusted by the equation above is dependent on the amount of cement produced, while the fixed costs of the operational expenditures remained the same, despite enlarging the production plan. Nonetheless, the total amount of the cement-grinding plants' electricity needs was changing year to year, since the annual cement production was slowly increasing to maximum and the operations began with one cement-grinding unit. Thus, the first years of operation have different amounts of operational expenditures for the facility, resulting in fluctuating income from cement and electricity sales, and furthermore, fluctuating variable costs, which were estimated to describe the reality of future operations. The inputs from the wind farm analysis are the annual back-up electricity, the annual excess electricity and the capital and operational expenditures of the wind farm. The annual income of cement remained at maximum possible income, since the infrastructure markets in the location has a greater demand than supply of infrastructure material, which means the more cement is produced the more will be sold.

The case company provided all the specific information about the business operations in the facility, which made it easy to calculate the annual in- and out cash flows. The cash flow of the operations calculated by the equation below is used for further calculation of net present value.

$$CF_{annual} = Income - (OpEx_{el.+wp} + OpEx_{cement} + CapEx_{investment}) \quad (12)$$

The cash flow is most dependent on the annual income of sold electricity and cement. In order to calculate the cash flow, the operational costs of the whole business are considered, and furthermore, investment costs when they occur. In order to calculate the NPV of the various scenarios, the present value of the future cash flows was calculated by discounting the cash flows with the WACC, in order to apply time value of money in the calculation.

The first project consisted of energy supply solutions for the case company that ought to supply the energy needs for two cement-grinding units. The present values of each year were summed in order to obtain the NPV of each scenario. Table 4 presents the NPV results for various scenarios in case study 1.

Energy supply alternative	Net Present Value
Scenario A	258 467 743 €
Scenario B	263 175 459 €
Scenario C	266 727 828 €
Scenario D	260 421 022 €
Scenario E	265 049 469 €
Scenario F	266 490 776 €

Table 4. NPV for various scenarios in case study 1 after a 16-year-long period.

According to the NPV results for case study 1, illustrated in Table 4, all the scenarios have positive NPV, but scenario C is the most lucrative option. The reason for scenario C being the most profitable option is the large wind energy capacity that results in larger income of sold electricity and no purchased electricity from the state utility.

In Figure 3, a presentation of the development of the NPV during the specific years of operation for every scenario is illustrated. Because this is an analysis made for energy supply of the cement-grinding plants, the overall costs for producing cement and income for selling cement will remain the same, while the electricity cost, i.e. purchased electricity from the state utility and/or operational expenditures for a possible investment in wind power, vary depending on the scenario and energy solution chosen. For this reason, the development of the NPV curves for various scenarios in case study 1 are very similar to each other.

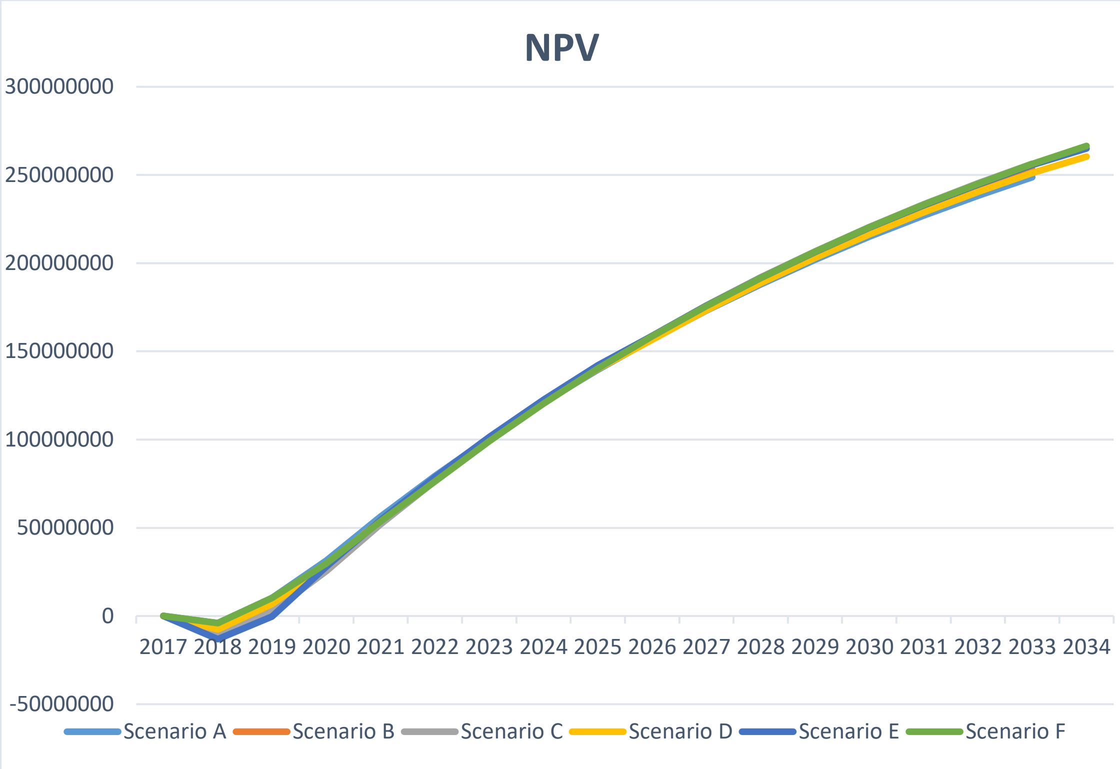


Figure 3. The NPV curve of the solution scenarios in case study 1.

As illustrated in Figure 3, the most profitable energy supply solutions are scenario C and F that are almost overlapping each other in the graph. Nonetheless, scenario C is slightly more lucrative than scenario F, since more electricity is sold during the years of operation. Figure 3 is reviewing the development of NPV during the years of operation. The advantages and disadvantages of the action-taking stage will be analysed comprehensively in the results and findings chapter of the thesis.

4.1.4 Action taking in case study 1 - Economic Value Added

Since the main purpose of the thesis is to compare NPV with EVA, the action-taking step of action research is re-visited in order to repeat the process and obtain results for the EVA of the project. The results obtained in the wind analysis, energy calculations, CapEx and OpEx estimation will be used in this chapter as well. The fixed and variable costs, production plan and capacity of the cement grinder plants remain the same as well, since the choice of evaluation tool does not change these parameters.

The case company provided a comprehensive cash flow sheet of how the annual EBITDA was calculated. The annual EBITDA was adjusted to describe the reality of the project with the same parameters as the cash flow in the NPV calculation.

$$EBITDA = Income - (OpEx_{cement} - OpEx_{el+wp}) \quad (13)$$

By obtaining the annual EBITDA for every year of operation, it was possible to calculate the NOPAT of the case company, i.e. net operating profit after taxes, by subtracting the annual costs of interest expenses, tax expenses, depreciation and amortization. NOPAT is used for calculating economic value added for the case scenarios. The capital charge is calculated by multiplying the total cost of capital with the WACC. In this case study, the cement grinder plants and possible wind farm investments in various scenarios represent the total cost of capital.

The EVA of the scenarios are presented in Figure 4. By subtracting the NOPAT with the capital charge, the EVA of the various scenarios were obtained. As illustrated in Figure 4, the EVA of the scenarios are lower than the NPV of the scenarios. Every energy supply solution is obtaining positive EVA, meaning that all the scenarios would create shareholder value.

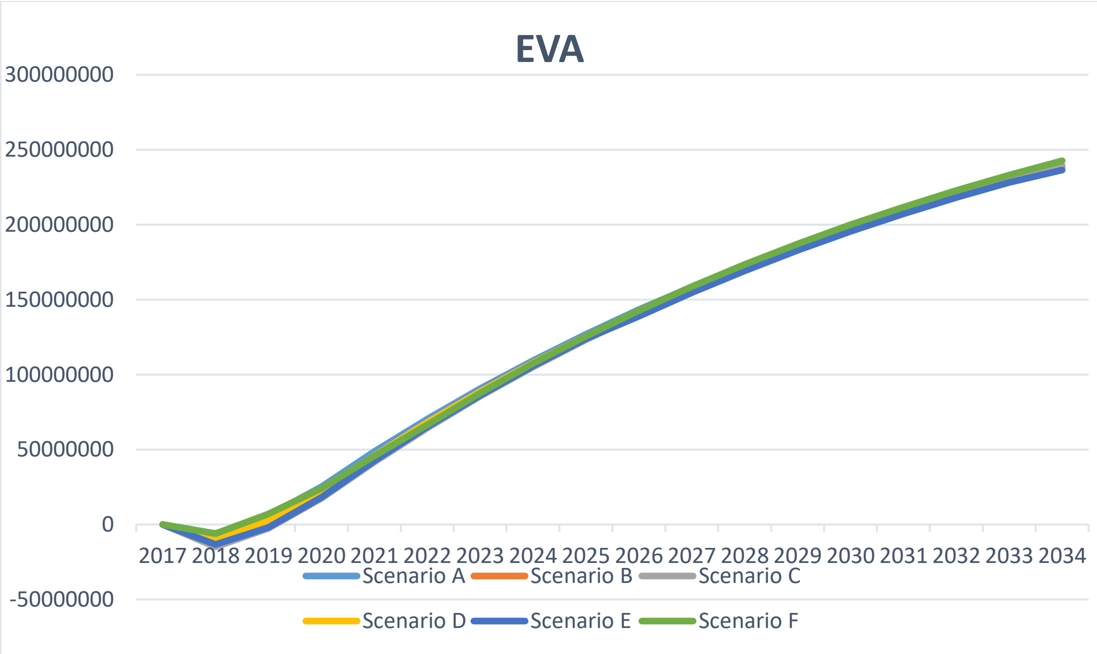


Figure 4. EVA of the solution scenarios in case study 1.

The EVA for every scenario is positive, but scenario C and F have the highest positive EVA. As can be seen in Figure 4, the production plan affects the EVA results tremendously, since cement production is obviously linked to income. It is easy to observe that the EVA for each project scenario is increasing year by year, due to step-wise enlargement of the production plan.

4.2 Case study 2 – Oil Shale Utilization for Cement Clinker Production and Power Generation

4.2.1 Problem formulation

The case company will utilize oil shale for power generation and production of cement. The company considers investing in an integrated cement plant. The project consists of mining, power generation and cement production activities. The power plant will use the Circulated Fluidized Bed technology for combustion of oil shale and will have a capacity of 30 MW. The coolant system will produce steam when oil shale is combusted and generate electricity with the help of a steam turbine.

The largest portion of power generation in the location is dependent on imported fuels, since there is a lack of petroleum resources in the country, except for oil shale. Due to the large oil shale deposits, the government supports oil shale projects and oil shale will last on a long-term basis. Furthermore, the CFB boiler produces oil shale ash when oil shale is combusted which together with limestone feedstock is to its chemical composition close to Portland cement chemistry, which is cement that hardens when it is exposed to water.

The oil shale consists of organic and inorganic compounds. Approximately fifteen percent of the oil shale composition is organic matter, which creates thermal energy and steam when combusted in the CFB boiler. Most importantly, the by-product in this process is oil shale ash. A considerable amount of the dry raw material produces oil shale ashes, which makes cement clinker production of oil shale ash relevant.

The integrated cement plant, fed with oil shale ashes and other raw materials for clinker production, has a sintering step in the end. The sintering process operates at 1400 centigrade and since oil shale does not contain high percentages of organic matter, the inorganic composition sets a limitation for the combustibility in the ICP kiln. The energy density of oil shale alone is not enough to reach the required temperature in the ICP kiln, since the calorific value of oil shale is approximately 1003 kCal/ton. Hence, adding another fuel in the ICP kiln, for instance petroleum coke, will enhance the calorific value and increase the heat to the desired temperature.

The case company considers another alternative for enhancing the calorific value in the ICP kiln, i.e. investing in a retorting system that will carry out a pyrolysis process of the oil shale producing considerable amounts of shale oils and gases. The produced shale oils and gases have the role of replacing the petroleum coke in the ICP kiln.

The main challenge is to determine whether it makes sense to generate high energy density organic oils and gases to be used in the ICP preheater and sintering oven by investing in a retorting system instead of importing petroleum coke. In order to determine whether it is more feasible to produce its own oils and gases from oil shale or buy petroleum coke, a comparison of the production cost of shale oil and gas to the transport and purchasing cost of petroleum coke has been executed. Moreover, analysing the NPV and EVA has been carried out to determine which of these alternatives would be more profitable for the case company. The feasibility study is used as a case study in this thesis to investigate whether it is better to use NPV or EVA as an evaluation tool in industrial projects.

4.2.2 Action planning – Energy supply scenarios for case study 2

In case study 2, two different solutions were available for the industrial system; buying alternative fuels to burn in the furnace, or investing in a retorting system for producing the amount of shale oils and gases needed to meet the thermal energy demand in the furnace, and obviously replace the alternative fuel, which in this case is petroleum coke. The possible evaluation tools for analysing the profitability of these scenarios in the project and help with the decision-making are NPV and EVA.

Alternatives	Solution	Description
Scenario A	Importing petroleum coke.	Petroleum coke is imported to the area of operation. In this scenario, there is no need for mining more oil shale. Nonetheless, import and transportation costs are considered.
Scenario B	Investing in a retorting system for shale oils and gases.	The investment of a retorting unit would provide shale oils and gases to be combusted in the furnace of the Integrated Cement Plant. The investment would also result in mining far more oil shale than usually, since oil shale is the raw material in the process.

Table 5. Scenarios for covering the thermal energy needs in case study 2.

Scenario B consists of investing in a retorting system that will provide the fuels needed to achieve the thermal energy requirements in the ICP kiln. Nonetheless, scenario B does not include the investment cost of the retorting system, since the task was to define how much capital could be invested in a retorting system by comparing the difference between the two scenarios' NPV and EVA so that scenario B would still be more profitable than scenario A.

The action research proceeded with using NPV to determine the profitability of the project. EVA is later used to compare the investment evaluation tools with each other.

4.2.3 Action taking in Case Study 2 – Net Present Value

Case study 2 required extensive research in the data-gathering phase and a more complex solution compared to the first case study. The processes were studied holistically to determine the in- and out mass flows of the industrial system and create economic values for these process flows. However, the estimated parameters consisted of determining the annual amount of oil shale used as raw material, the amount of produced shale oils and gases produced in the retorting system and the amount of SO3 emissions in the sintering process.

The amount of produced shale oils and gases were optimized by determining the thermal energy requirements in the ICP kiln. The thermal energy need and calorific value of the shale oils and gases are multiplied in order to determine how much shale oils and gases are required to meet the thermal energy demand in the ICP kiln. Since the calorific value of residues and shale gas in the pyrolysis process was low, the research focused on producing the required amount of shale oil that would meet the thermal energy demand in the ICP kiln. The residues and shale gas produced in the retorting unit can be utilized for other heating purposes in the ICP.

$$mf_{shale\ oil} = E_{required\ thermal\ energy} / H_{shale\ oil} \quad (14)$$

$H_{shale\ oil}$ represents the calorific value of shale oil. By dividing the amount of needed thermal energy, $E_{required\ thermal\ energy}$, with the calorific value of shale oil, $H_{shale\ oil}$, it is possible to know how much shale oil is needed in the ICP kiln in order to replace the use of petroleum coke. By using the required mass flow of shale oil in the ICP kiln, the needed amount of oil shale feed as raw material can be calculated by the formula below.

$$mf_{oil\ shale} = mf_{shale\ oil} / (m\text{-}\%_{shale\ oil\ in\ kerogen} * m\text{-}\%_{kerogen\ in\ oil\ shale}) \quad (15)$$

Calculation of the additional variable costs for scenario B is made by determining the amount of oil shale needed for raw material in the retorting unit. Additional oil shale mining and transportation to the production site enlarges the variable costs for the plant and has to be considered when calculating the operational expenditures. However, it is obtained by multiplying the amount of needed oil shale raw material with an estimated price on mining and transportation provided by the case company.

$$VC_{mining\&transportation} = mf_{oil\ shale} * P \quad (16)$$

In this case study, the main difference between the two scenarios are the operational costs. The difference between the two scenarios' operational costs is the amount of capital that can be invested in a retorting system.

The CapEx for the industrial system, including the CFB boiler, steam turbine and ICP, were provided by the case company. The operational costs, i.e. fixed and variables costs of the industrial system alone, were also provided by the case company.

The NPV analysis made in case study 2 had some noteworthy results, since it proved that investing in a retorting system would not be more profitable than purchasing petroleum coke as an alternative fuel in the ICP kiln. In addition, the retorting unit's investment cost was excluded from the NPV calculation, which supports the argument that scenario A is far more profitable than scenario B, since it would result in a less positive NPV for scenario B. The NPV of both scenarios is presented in Table 6.

Thermal Energy Supply Alternatives	**Net Present Value**
Scenario A	569 187 425 €
Scenario B	555 247 601 €

Table 6. NPV of the scenarios in case study 2 during a 10-year-long period.

Most probably, a retorting unit solution would still obtain a positive NPV but would drain cash from the company rather than contribute to a profitable solution. In Figure 5, the NPV curves for both scenarios are introduced, and one can see how scenario A is above scenario B, but considering that the investment cost is excluded from the calculations, scenario A is far more profitable than scenario B.

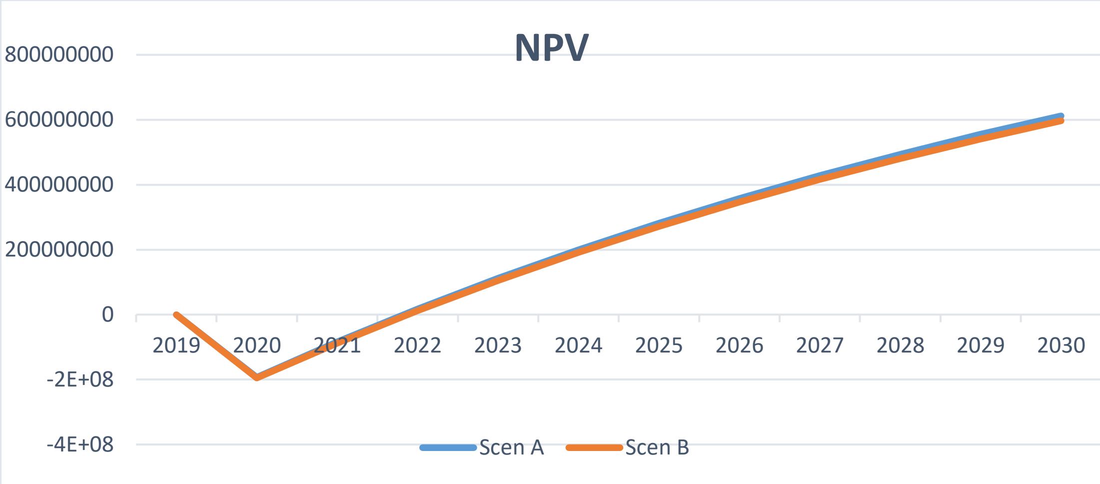


Figure 5. NPV graph for the scenarios in case study 2.

4.2.4 Action taking in case study 2 - Economic Value Added

The action-taking step was re-visited in order to analyse the advantages and disadvantages of EVA. The case company provided the capital and operational expenditures of the industrial system and other financial statements. The major step in calculating the EVA of the project was to define the annual EBITDA in order to acquire the annual NOPAT of the case company's operations. Furthermore, the cost of capital is multiplied by the WACC in order to obtain the capital charge needed to calculate the annual EVA.

The EVA analysis was depicting the same conclusion as the NPV analysis, meaning that scenario A was proven to be more profitable than scenario B. The EVA depends heavily on invested capital, which supports the statement that scenario B is less profitable than scenario A. Due to excluding the retorting unit's investment cost from the EVA calculation, the EVA appears to be more profitable than it is.

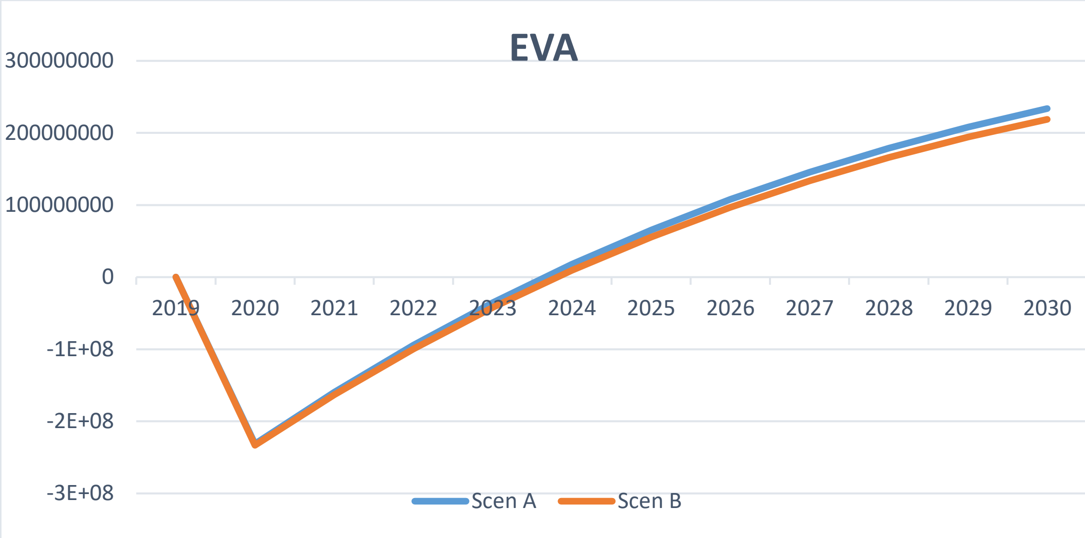


Figure 6. EVA curve for the scenarios in case study 2.

In Figure 6 above, it is possible to see how the EVA of the project scenarios is behaving during the lifespan of the ICP.

4.3 EVA in comparison with NPV – Evaluation

When comparing the EVA approach with the NPV approach, it is easy to argue that NPV gives higher values than the EVA. EVA and NPV results of both cases will be presented in a graph to obtain a better understanding of how EVA and NPV differ from one another. In Figure 7, the most lucrative scenarios in case study 1, i.e. scenario C and F, are presented in a graph with both the NPV and EVA results. Figure 7 gives a comprehensive view of the difference between the investment evaluation tools. In Figure 7 and 8, it is possible to compare the NPV and EVA results for both case studies in a graph.

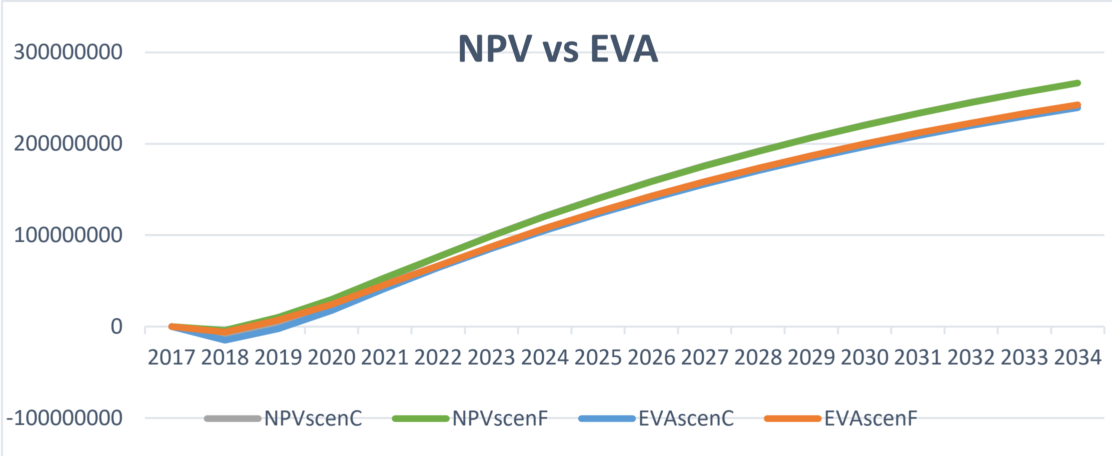


Figure 7. NPV versus EVA for scenario C and F in case study 1.

Scenario C and F were the most lucrative energy supply options in case study 1. The NPV results of scenario C and F overlap each other in the figure, but the main target of Figure 7 and 8 is to compare NPV and EVA as investment evaluation tools.

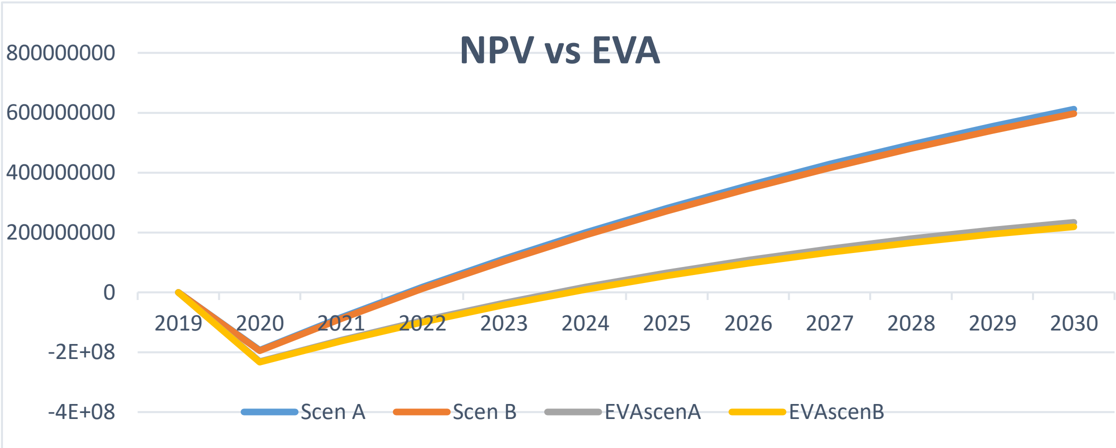


Figure 8. NPV versus EVA for both scenarios in case study 2.

As noted in Figure 7 and 8, the NPV curve is always situated above the EVA curve, since EVA excludes all non-cash expenses, while NPV does not. However, EVA is the profit that the company and shareholders obtain, which makes these graphs even more significant when the differences are large.

5 Results and Findings – Specify Learning

This chapter will introduce the results and findings for the NPV and EVA results of the case studies made in the empirical research of this thesis. Furthermore, two managers from the case company have been interviewed in order to get a manager's point of view in decision making and evaluation of industrial projects. In addition, the interviews have also been undertaken to asses when and how NPV versus EVA is necessary to use as evaluation tool in industrial projects. The results and findings, based on both theoretical and empirical approaches from this study, are supported by the answers from the interview and personal insights.

There are several factors to consider when evaluating a project's profitability. For instance, a project is profitable with a positive NPV and EVA, but it does not necessarily tell the whole background of the project's profitability, since these evaluation tools do not describe the same advantages and disadvantages of the project. This subchapter will answer the first question in the thesis; what investment evaluation tools are required to predict a project's profitability?

The first interviewee was most often working with start-up and green field projects. He mentioned that the main goal of project evaluation is to attract investors and decision makers and letting them understand that the project is profitable and why they should invest. In order to do that, an overall description of the project's profitability must be drawn, and NPV works well in that sense, since business success and future events that may affect the project are difficult to predict with desired confidence and is not required in NPV calculations to the same extent as in other investment evaluation methods. In contrast, EVA has more factors involved, such as the total cost of capital, NOPAT and the GAAP-adjustments that can be complicated to calculate at the beginning of a project, since some of these factors are not known in the early stage of a project. The EVA of a project is most often not required by investors, partly because it is a new concept and has not been used as much as NPV.

The second interviewee mentioned that NPV describes the relative profitability of a project well and is an efficient tool for comparing investment scenarios within the same project. However, EVA considers a shareholder's point of view of the project, which is a huge advantage when attracting investors and new shareholders.

In Figure 3 and 5, the NPV curves of both case studies are presented and one can see how NPV is suitable for giving an investor or manager an overall view of the project's profitability, since it is easy to compare different energy supply scenarios for the same project. NPV is better for start-up and new projects, since the future in uncertain, but NPV can depict the future for any project or business operation quite well and be used for determining whether to execute the project at all, while EVA can be used for attracting investors, since it describes how much the shareholders and investors can expect in return for their invested capital.

However, what are these evaluation tools specifically missing? NPV works well for describing the profitability of the project's lifecycle, but when a company wishes to attract investors, NPV alone does not necessarily fulfil the task. There are add-on tools calculated with the NPV to holistically illustrate a project's profitability to investors. For instance, Internal Rate of Return or EBITDA margin are add-on tools used in investment analysis to complete the purpose of NPV. Similar aspects like these are calculated in order to give investors a better understanding of how to benefit from investing in the company or project. However, EVA is directly measuring a company's success and measures how much investors can expect in return linked with the amount of invested capital in the first place. EVA describes the true profit and value added that the company obtains because of the project, after tax expenses, interest expenses, depreciation and amortization are excluded. NPV does not exclude these expenses, which might give the investors a false view of how profitable it would be to invest in the project. In addition, an investor may have to guess how much value the project is creating for shareholders and the company when looking at the NPV.

In Figure 8, the NPV and EVA of the scenarios in case study 2 are compared to each other and one can see that the EVA of the scenarios is clearly smaller than the NPV in this capital-intensive project. EVA cannot be greater than the NPV of a project due to excluding all the non-cash expenses, meaning that the EVA in Figure 8 represents economic profit. If an investor reviews the EVA results, which in the scenarios of case study 2 are approximately half of the NPV, he or she will obtain a more comprehensive view of how profitable the project is and how much to expect in return. The oil shale project in case study 2 is a capital-intensive project with large non-cash expenses, which makes the NPV of the project much larger as a result of not excluding these factors.

In both the NPV and EVA approach, it is possible to notice increased shareholder value. Both evaluation tools should be used to asses both the investor's point of view and the company's point of view of the project, since these factors do not always correlate. Increasing shareholder value is an important factor in today's business world, since companies would otherwise have a hard time attracting investors. Thus, it is possible to observe whether the project is creating additional value for shareholders by using NPV, but it is not necessarily measuring how much value is created. When the NPV is greater than zero, it shows us an increase in shareholder value, but not precisely how much it has increased. By comparing the NPV and EVA in this context, EVA is far more suitable for predicting how much value it is possible to create for shareholders because of a project, since EVA is the value that the project brings to the company and shareholders.

In Table 4 and 6, the EVA of the scenarios in both case studies are presented. They are both showing increased shareholder value and illustrating how much additional value is created, hence calling it economic value added. By dividing the EVA with the total cost of capital, it is possible to obtain a percentage of how much value is created, which equals the economic spread, i.e. ROIC subtracted with the WACC, presented in chapter 2. The positive EVA of the scenarios in both case studies creates shareholder value and is easier to observe in the EVA results compared to NPV results, since the discounted cash flow in the NPV analysis contains the non-cash expenses as well.

In the second interview, the interviewee answered that EVA is more suitable for attracting investors, since it takes an owner's point of view of the project. However, investors may not necessarily ask for the EVA of the project, since the NPV is considered enough to predict the relative profitability of a project even though it does not measure shareholder value at all.

Another interesting feature is that EVA can also be suitable for comparing projects of different sizes by using the economic spread. For instance, the first project in case study 1 is comparable to the oil shale project in case study 2 by using EVA, since one can compare the productivity of the projects with each other, and thereby determine which project is more profitable.

6 Conclusions

The main purpose of investment evaluation tools is to evaluate whether a project is profitable or not. However, various tools describe different views on the project's profitability. Net present value is an established tool for investment analysis and has been used for decades. NPV is proven to be a proper tool for decision makers and investors. However, EVA has quite a few advantages when it comes to measuring a company's success and performance.

As stated in the results and findings, there is a considerable difference between EVA and NPV. In my opinion, NPV has quite a few advantages, since it can be applied to any kind of project and will probably predict a project's future well. However, EVA seems to be an enhanced version of NPV. Depreciation and amortization, tax and interest expenses are non-cash expenses, i.e. not profit for the company nor the shareholders. Thus, EVA has a huge advantage when it comes to measuring the true success of a project because of excluding non-cash expenses from the cash flows. The use of EVA in investment analysis should be further researched and used within companies for decision-making in the future, since value creation is one of the most important parameters for executing a project.

In the future, further research within investment analysis of industrial projects with both net present value and economic value added as evaluation tools should be carried out, since NPV describes the relative profitability of the project, while EVA represents the actual money that the company and shareholders will receive. Thereby, the difference between NPV and EVA is an interesting topic to investigate in the future, since it has the tendency to describe how much non-cash expenses are present in the project.

By comparing case study 1 and 2, one can observe how much non-cash expenses the company has in its operations. In Figure 7, the NPV and EVA of the scenarios in case study 1 are not that distinct from each other, while the scenarios in case study 2 have large non-cash expenses that make the difference between the NPV and EVA results very large. In case study 1, NPV works approximately as well as EVA, but in case study 2, which is a capital-intensive project and larger than the first project, the NPV results are not describing the profitability realistically, since the non-cash expenses cover a large part of the NPV, which is an inconsistent way of comparing projects of different sizes.

When taking productivity, shareholder value and economic spread under consideration, EVA describes these factors well compared to net present value. In contrast, by measuring the difference between NPV and EVA, shareholders will receive a different view of the project. Companies seek to maximize shareholder value and productivity in their operations by having minimum non-cash expenses the productivity will increase as well, which will attract investors even more.

I think that EVA is more efficient when describing the performance of a company on a monthly basis. Investors and shareholders will be more attracted to a company's ongoing business by viewing the monthly or annual EVA in comparison to what NPV has to offer. Nonetheless, while analyzing the investments of industrial projects, plenty of different tools are most often used, but most importantly, the gap between a feasible project and the most profitable project possible, is large.

In conclusion, I think that research in combination of NPV and EVA in investment evaluation of industrial projects is an interesting topic for the future. Furthermore, since companies are striving for more productive business operations, extensive research in estimation of the equity ratio and non-cash expenses for more effective capital ought to be carried out, since it will increase the productivity of companies, and thereby, keep the shareholders satisfied.

The case studies were suitable for this topic, since they are very different from each other. Comparing the profitability of two different industrial projects worked well with NPV and EVA as evaluation tools, since they brought compelling arguments for the research.

7 Svensk sammanfattning – Utvärderingsverktyg för investeringar inom industriella projekt

7.1 Introduktion

Denna avhandling görs för ett ledande olje- och cementföretag i Marocko. Företaget utvecklar kommersiell användning av oljeskiffer och planerar att investera i industriella anläggningar för förädling och förbränning av oljeskiffer för energi- och cementproduktion. Syftet med denna avhandling är att evaluera dessa projekt med hjälp av två investeringsanalysverktyg och undersöka vilket av dessa som beskriver projektets lönsamhet bättre.

Tendensen att investeringarna ökar företagets aktieägarvärde kommer att tas i beaktande när investeringsanalysverktygen jämförs med varandra. Genomförbarhetsstudier har gjorts för projekten för att uppfylla avhandlingens syfte. Studierna gjordes genom att analysera projektens olika energiförsörjningsscenarier med de ovannämnda investeringsanalysverktygen.

Investeringsanalysverktyg beskriver lönsamheten för ett projekt bra, men olika verktyg beaktar inte samma faktorer. Olika verktyg har nämligen olika synvinklar på ett projekt och kan därmed beskriva ett projekts lönsamhet på olika sätt. Företagsledares beslut om man ska genomföra ett projekt eller inte kan bero på flera olika faktorer. Den viktigaste faktorn i de här besluten är att projektet ska skapa värde för företaget och bidra med ekonomisk vinst.

Fallföretaget har ungefär 80 aktieägare, vilket ställer mera krav på att projekten ska vara lönsamma. För att uppnå målet med denna avhandling ska följande frågor besvaras:

1. Vilka investeringsanalysverktyg krävs för att förespå ett projekts lönsamhet? Kan olika typ av projekt påverka valet av verktyg?

Genom att besvara den här frågan kan man få en bättre förståelse av hur och varför företagsledare väljer en viss typ av investeringsanalysverktyg, eftersom tillämpningen av dessa modeller i investeringsprojekt har små skillnader som leder till olika resultat.

2. Vilka faktorer är det som verktygen inte lyckas beskriva i investeringsanalyserna?

Investeringsanalysverktygen kan hjälpa företagsledare och investerare reda ut ifall ett projekt är lönsamt eller inte, men inte nödvändigtvis hur lönsamt det är för en investerare att investera i detta projekt med tanke på hur mycket avkastning investeraren kan förvänta sig att få tillbaka.

3. Hur bra lyckas dessa verktyg beskriva ökningen av aktieägarvärde?

Produktivitet och aktieägarvärde är två av de viktigaste faktorerna i dagens företagsvärld, eftersom de flesta företagen finansieras med investerares pengar. I denna avhandling kommer Net Present Value (NPV) och Economic Value Added (EVA) att användas som investeringsanalysverktyg. Dessa verktyg skiljer sig mycket från varandra men är värdefulla i industriell projektverksamhet. Målet med denna avhandling är att teoretiskt undersöka hur dessa verktyg mäter aktieägarvärde och stödja argumenten med empirisk forskning som gjorts i samarbete med fallföretaget genom att analysera hur olika energilösningar kan påverka aktieägarvärdet i fallföretagets kommande projekt.

7.2 Teori

I teoridelen undersöks två olika investeringsanalysverktyg, dvs. NPV och EVA. De här investeringsanalysverktygen passar bra för evaluering av industriella projekt och ska användas för att evaluera företagets kommande projekts lönsamhet och tendensen att öka aktieägarvärdet.

7.2.1 Net Present Value – NPV

NPV är ett evalueringsverktyg som används för att identifiera ett projekts ekonomiska värde. NPV tar pengars tidsvärde i beaktande, dvs. en valuta kan i dag ha mindre värde i morgon. Företagsledare använder NPV för att identifiera hur lönsamt ett projekt är, genom att beakta kapitalförhållandet i det investerade kapitalet och den avkastning som krävs för att göra projektet lönsamt. Med positivt NPV är projektet lönsamt, medan negativt NPV tyder på att företaget kommer att gå med förlust som en följd av investeringen. Om NPV är lika med noll, innebär det att företaget varken går med förlust eller vinst då de investerar i ett projekt. Ju större NPV ett projekt erhåller, desto mer lönsamt är det.

NPV är känt för att ta pengars tidsvärde i beaktande (engelska: Time value of money). Detta tillämpas genom att beräkna nuvärdet av framtida kassaflöden. För att erhålla de årliga nuvärdena, diskonteras kassaflödena för varje år med en konstant diskonteringsränta.

NPV= ∑ {nuvärde / (1+r)^n} – investerat kapital

De årliga kassaflödenas nuvärden för varje period diskonteras med diskonteringsräntan och summeras därefter. Diskonteringsräntan presenteras som bokstaven r i ekvationen och antalet perioder med bokstaven n. Flera företag använder en viktad snittkostnad av kapitalet (engelska: Weighted Average Cost of Capital) som diskonteringsränta. När man har erhållit projektets nuvärde under n perioder, subtraheras summan med den totala mängden investerat kapital. Det beräknade värdet representerar NPV för projektet.

Fördelarna med NPV-metoden är att den beskriver ett projekts framtid relativt bra och inkluderar pengars tidsvärde och inflation i beräkningarna, jämfört med andra metoder som t.ex. IRR (Internal Rate of Return). IRR tar inte hänsyn till inflation, utan enbart hur många år det dröjer tills investeringen har betalat sig tillbaka. NPV har fördelen att beräkna kapitalkostnaden på ett mera realistiskt sätt på grund av inflationsfaktorn. Å andra sidan kan NPV-resultat vara missledande, eftersom de inte beskriver produktivitet. Hur mycket avkastning kan ett företag förvänta sig efter att investera en viss summa i ett projekt? Man kan ofta observera ökat aktieägarvärde då man analyserar NPV-resultat, men man kan inte specifikt mäta hur mycket de har ökat.

7.2.2 Economic Value Added – EVA

I dagens affärsvärld ställs större krav ställts på företag av investerare och ägare, vilket har lett till att de måste öka på aktieägarvärdet. Företagsledare vill maximera aktieägarvärdet genom att använda företagets resurser så effektivt som möjligt. De flesta företag försöker maximera sina vinster, men det betyder inte nödvändigtvis bokföringsmässig vinst som innehåller icke-kontanta kostnader (engelska: non-cash expenses), utan äkta vinst som höjer företagets tillgångar och aktieägarvärde.

EVA är ett evalueringsverktyg som mäter ett företags värde och dess verksamhetsprestanda. EVA utvecklades av Stern Stewart & Co. för att analysera aktieägarvärde i investeringskalkyler. Det här verktyget har visat sig vara mycket effektivt när det kommer till att beskriva den äkta ekonomiska vinsten som ett företag skapar med sin verksamhet. Liksom NPV är ett projekt lönsamt då det erhåller ett positivt EVA, medan ett negativt EVA tyder på att det är fråga om ett olönsamt projekt som minskar på aktieägarvärdet. Det finns flera olika sätt att tillämpa EVA på ett företags verksamhet eller ett specifikt projekt. I denna avhandling kommer kalkylen att fokuseras på operativa aktiviteter som skapar värde för både företaget och aktieägarna.

EVA = NOPAT – C*WACC.

NOPAT representerar nettoresultatet efter skatt (engelska: Net Operating Profit After Taxes), medan C representerar den totala mängden kapital som har investerats i projektet eller som företaget har. WACC multipliceras med det totala kapitalet för att få en kapitalavgift. Nettoresultatet efter skatt anses vara den riktiga vinsten som ett företag erhåller från sina operativa aktiviteter, eftersom det inte inkluderar avskrivningar, räntekostnader och skattekostnader. NOPAT kan beräknas från EBITDA (engelska: Earnings before Interest, Taxes, Depreciation and Amortization), dvs. intäkter före exkludering av avskrivningarna, räntekostnaderna och skattekostnaderna, eller EBIT (engelska: Earnings before Taxes), intäkter före exkludering av skattekostnader. Genom att subtrahera dessa faktorer från de totala intäkterna får man nettoresultatet efter skatt. När nettoresultatet efter skatt överskrider kapitalavgiften, har man skapat värde för både företaget och aktieägarna, vilket är det som EVA representerar.

Att beräkna kapitalavgiften är ett av de viktigaste stegen i EVA, eftersom eget kapital och investerarnas kapital ska inkluderas för att få en verklig beskrivning av hur projektet skapar värde. I kapitalavgiften inkluderas även en riskfaktor som skapas då man multiplicerar den totala mängden kapital med den viktade snittkostnaden av kapital. Då kan en investerare få en uppfattning om hur stor avkastning hen kan få om hen investerar i projektet. Kapitalavgiften representerar hur mycket av aktieägarnas kapital som riskeras. Därmed har företaget lyckats betala tillbaka aktieägarna då EVA är lika med noll, medan företaget höjer aktieägarvärdet med ett positivt EVA. Om man härleder EVA-ekvationen, kan man få fram verktygets andra viktiga egenskaper:

EVA = NOPAT – C*WACC.

NOPAT = C*ROIC.

Nettoresultatet kan beräknas genom att multiplicera den totala mängden kapital med avkastningen på det investerade kapitalet (engelska: Return on Invested Capital). Den härledda ekvationen kommer att se ut som följande:

EVA = C*(ROIC – WACC).

”ROIC – WACC” kallas den ekonomiska spridningen och det är den egenskapen i EVA som beskriver produktivitet, eftersom skillnaden mellan avkastningen på det investerade kapitalet och kapitalet som riskeras, representerar den avkastning som projektet har skapat åt sina aktieägare i procent. Den ekonomiska spridningen beskriver hur mycket man kan förvänta sig i avkastning i jämförelse med den mängd som man investerat i projektet. Det är orsaken till att EVA anses vara ett mycket effektivt verktyg för investeringsanalys. EVA kan även användas för att undersöka vilka operativa sektioner i verksamheten som har det mest effektiva kapitalet. Man kan göra det genom att räkna EVA för varje operativ sektion och jämföra dessa med varandra. Därmed kan investerare och företagsledare reda ut vilka delar av verksamheten som inte är lönsamma med tanke på mängden fast kapital.

Även om EVA-ekvationen kan vara lätt att förstå är tillämpningen komplicerad på grund av faktorer i nettoresultatet och beräkning av den totala mängden kapital.

7.3 Metod - åtgärdsforskning

År 1946 introducerade Kurt Lewin metoden åtgärdsforskning (engelska: Action Research) när han forskade i föränderliga miljöer i sociala system. Åtgärdsforskning är en stegvis metod som används för att skapa en lösning på problem i organisatoriska, pedagogiska eller sociala sammanhang. Tidigare var åtgärdsforskning en metod för att lösa problem i sociala samhällsvetenskapliga sammanhang, men numera har metoden utvidgat sitt forskningsområde och man kan tillämpa den i både organisatoriska problem och affärsprocessers utvecklingssammanhang. De fem följande stegen hör till åtgärdsforskning:

- problemdefinition
- åtgärdsplanering
- åtgärdstagande

- utvärdering
- specificerad inlärning.

Första steget i åtgärdsforskningen är att definiera problemet. Efter att man har definierat problemet, samlas data om ämnet för att empiriskt kunna hitta en lösning. När man har samlat tillräckligt med data, kan man ställa upp flera möjliga lösningar till problemet. Andra steget i åtgärdsforskning kallas åtgärdsplanering. I åtgärdsplaneringsskedet inkluderas omfattande datainsamlingsaktiviteter där man ställer upp olika lösningar för att kunna jämföra lösningarna med varandra. I det här skedet har redan alla möjliga lösningar analyserats och evaluerats för att kunna jämföra dem med varandra. I det tredje steget, åtgärdstagande, väljer man en lösning som ska analyseras noggrannare. Det fjärde steget i åtgärdsforskningen består av att utvärdera konsekvenserna som lösningen har på organisationen. I det sista steget, specificerad inlärning, går man igenom lösningens för- och nackdelar för att kunna reflektera över hur denna lösning kommer att vara lönsam för kunden eller organisationen.

7.3.1 Tillämpning av åtgärdsforskning i fallstudierna

Åtgärdsforskningen användes som undersökningsmetod för att genomföra lönsamhetsstudier av två olika typer av industriella projekt. Företaget tänker investera i energiintensiva industriella anläggningar som behöver lönsamma energilösningar för att minimera de årliga kostnaderna. I problemformuleringen skapades en energilösning för de industriella projekten. Företaget gav intern information och data om projektets operativa aktiviteter och kostnader. Ekonomiska och tekniska data i produktionsplanering, tidsplanering och finansiering ommodellerades för att beskriva projektens verklighet i framtiden.

I åtgärdsplaneringen undersöktes olika energilösningar och ifall det finns teknikleverantörer för dessa lösningar i området. Energibalanser gjordes för att optimera energilösningarnas årliga elektricitetsproduktion och hur mycket diverse energilösningar skulle kosta, vilket innebär både investeringarna och de årliga kostnaderna.

Företaget gav optimerade värden av de operativa och fasta kostnaderna i euro per enhet för de två projekten som skulle evalueras. De operativa och fasta kostnaderna omjusterades enligt projektets verkliga produktionsplan som ändrades varje år enligt företagets strategi. Faktorer som EBITDA, anläggningarnas kapitala kostnader, projektets kapitalförhållande och försäljning var mer eller mindre kända, men omjusterades enligt den framtida produktionsplanen och marknadsmöjligheterna under de första produktionsåren.

Båda projekten hade flera energilösningsalternativ. Scenarierna var tillagda i finansmodellen för att energilösningarna skulle kunna jämföras med varandra. Energilösningsalternativen bestod av inköpt elektricitet från det lokala energibolaget, vindkraftsinvesteringar, inköp av alternativt bränsle och nya energiteknologier. De kapitala och operativa kostnaderna (engelska: Capital and Operational Expenditures) för varje energilösning optimerades för att kunna göra en finansiell analys av projekten.

I åtgärdsplaneringsskedet jämfördes scenarierna med varandra med att beräkna deras EVA och NPV. I det tredje steget i åtgärdsforskningen, dvs. åtgärdstagning, väljer man en energilösning som är ekonomiskt den mest lönsamma med avseende på EVA och NPV. Varje scenario baserar sig på att de skulle generera tillräckligt med elektricitet för att täcka energibehoven i anläggningarna.

I det fjärde skedet av åtgärdsforskning, dvs. utvärdering, evaluerar man både tekniska och ekonomiska påverkan som energilösningen har på företagets affärsstruktur. I det sista skedet av åtgärdsplanering, specificerad inlärning, identifieras och utvärderas lösningens för- och nackdelar. Från företagets synpunkt är arbetet ett investeringsförslag, men från den akademiska synpunkten undersöks investeringsanalysverktygens för- och nackdelar i investeringsanalys av industriella projekt.

7.4 Empirisk forskning – Fallstudierna

I det här kapitlet ska fallstudierna presenteras med deras energilösningsscenarier. EVA- och NPV-resultaten för alla energilösningsscenarier introduceras och jämförs med varandra. Den ekonomiskt mest lönsamma scenarion kommer att introduceras, men kommer inte att ha en signifikant roll i denna avhandling, eftersom det är fråga om hur investeringsanalysverktygen skiljer sig från varandra då man evaluerar ett projekts lönsamhet.

7.4.1 Fallstudie 1 – Kontinuerlig energiförsörjning för två cementanläggningar

Företagets verksamhet baserar sig på cementproduktion för bygg- och infrastrukturindustrierna. De har investerat i en cementanläggning som är lämplig för cementproduktion i stor skala. På grund av de ambitiösa investeringarna i byggnadssektorn är cementproduktion mycket lönsamt i verksamhetsområdet. Därmed har företaget övervägt att investera i ytterligare en cementanläggning för att öka den årliga cementproduktionen.

Den första anläggningen har ett energiförsörjnings avtal med statens energisektor, men kapaciteten för en till anläggning kommer att kräva effektivare lösningar än tidigare. För tillfället har den första anläggningen en ströminmatning av 3000 kilowatt och en kontinuerlig elektricitetskonsumtion av 1700 kilowatt. Att tillägga en ny anläggning av samma typ skulle öka ströminmatningen till 5500 kilowatt och den kontinuerliga elektricitetskonsumtionen till 3300 kilowatt. Företaget siktar på att ha en oavbruten produktion som körs 24 timmar i dagen, vilket gör energiförsörjningsfrågan ännu mera signifikant. Målet med undersökningen är att hitta en energilösning som möter anläggningarnas energibehov och som är ekonomiskt lönsam.

Scenarierna i denna fallstudie är baserade på inköpt elektricitet från statliga energiföretaget, vindkraftsinvesteringar och en kombination av dessa. Det finns scenarier med både nya och använda vindturbiner. En cementanläggning har en 3 megawatts kapacitet, vilket betyder att två anläggningar har en 6 megawatts kapacitet. Vindkraft är en förnybar energiteknologi, vilket betyder att den konverterar energin i vindens kinetiska energi till elektricitet. Därmed är den årliga energiproduktionen optimerad för att möta cementanläggningarnas energibehov.

- Scenario A:
  - Inköp av elektricitet från statens energisektor (6 megawatt).
- Scenario B:
  - Inköp av elektricitet från statens energisektor (3 megawatt).
  - Vindkraftsinvestering (3 megawatt).
- Scenario C:
  - Vindkraftsinvestering (6 megawatt)
- Scenario D:

    - Inköp av elektricitet från statens energisektor (3 megawatt).
    - Vindkraftsinvestering, begagnade turbiner (3 megawatt).
- Scenario E:
    - Vindkraftsinvestering, begagnade turbiner (6 megawatt)
- Scenario F:
    - Vindkraftsinvestering (6 megawatt)
    - Investerar i turbinerna med en stegvismetod, dvs. en tredjedel av turbinskapaciteten köps varje år i tre år.

För att göra en ekonomisk bedömning av projektet, krävdes en vind- och energianalys av vindkraftsinvesteringarna, dvs. det gjordes en optimering av hur mycket elektricitet man kan förvänta sig att dessa scenarier skulle generera årligen. Genom att analysera vindturbinernas energibalanser och vindhastigheterna i området, kunde det klargöras hur många timmar per dag vindfarmen generar tillräckligt med elektricitet för att möta cementläggningarnas energibehov och hur många timmar om året den inte gör det. Då vindfarmen inte genererar tillräckligt med elektricitet, inköps el från statens energisektor som reservelektricitet. Å andra sidan, säljs överloppselektriciteten till statens energisektor som äger elnätet i området då vindfarmen genererar mera elektricitet än det som behövs. Vindanalysen gjordes för varje tre timmars period året runt. Timmarna då vindfarmen genererar överloppselektricitet summerades för att få ett årligt värde för överloppselektricitet. Samma gjordes för reservelektricitet som köps av statens energisektor.

$$E_{reserv} = E_{krävda} - E_{genererad}$$

$$E_{överlopps} = E_{genererad} - E_{krävda}$$

De kapitala kostnaderna för vindfarmen optimerades med en €/MW-metod, medan de operativa kostnaderna optimerades med en €/MWh-metod från Wind Energy – The Facts (Wind Energy – The Facts, 2006). Därmed är den kapitala kostnaden för vindfarmscenarierna beroende av vindfarmens kapacitet, medan de operativa kostnaderna beror på hur mycket elektricitet vindfarmen genererar årligen.

Kassaflödet omjusterades så att det skulle beskriva verksamhetens verkliga tillstånd i framtiden. De rörliga kostnaderna omjusterades beroende på produktionsplanen. De rörliga kostnaderna ändrades enligt följande ekvation:

Rörliga kostnader = $Produktion_{cement}$ * $Pris_{rörliga\ kostnader}$

De fasta kostnaderna påverkas inte av produktionsplanen, vilket betyder att de är konstanta oberoende av om cementproduktionen ökar eller minskar. Elektricitetskostnaderna ändrades också årligen, eftersom ökande cementproduktion leder till större elektricitetsbehov.

Kassaflöde = Inkomst – (Operativa $kostnader_{cement}$ + Operativa $kostnader_{el+vindkraft}$ + $Investeringskostnad_{vindkraft}$)

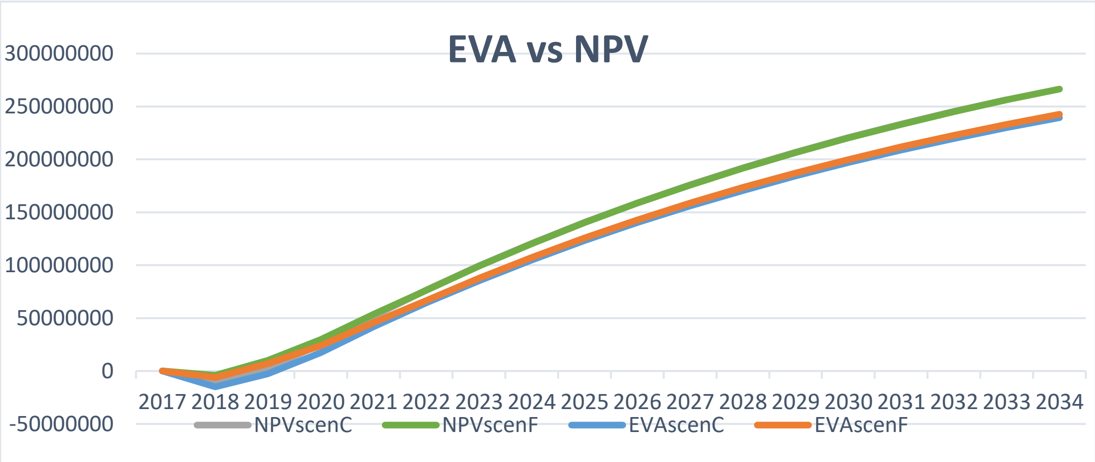
Kassaflödet beräknades med ekvationen ovan. Investeringskostnaden och de operativa kostnaderna för energiförsörjningsalternativet tillades i kassaflödesberäkningarna. Inkomsten består av både såld cement och överloppsenergi. Inkomsten från försäljning av överloppsenergin spelar en stor roll i de olika scenarierna, eftersom den ökar på det årliga kassaflödet, vilket i sin tur ökar på scenariernas lönsamhet. Kassaflödet för varje år diskonterades med den viktade snittkostnaden av kapitalet för att tillämpa tidsvärde av pengar i framtida kassaflöden. Därmed kunde man beräkna NPV för alla energilösningarna och besluta vilket av dessa alternativ som är det mest lönsamma.

Företaget gav information om deras årliga EBITDA, vilket omräknades för att beskriva de verkliga intäkterna som företaget kommer att få under sitt verksamhetsår. Genom att subtrahera avskrivningar, skatt- och räntekostnader från denna årliga EBITDA, beräknades det årliga nettoresultatet och EVA för verksamheten med följande ekvation:

EVA = NOPAT – C*WACC.

De kapitala kostnaderna multiplicerades med den viktade snittkostnaden av kapitalet. EVA för kommande år diskonterades med den viktade snittkostnaden av kapitalet för att tillämpa tidsvärde av pengar i de kommande årens EVA. De faktorer som gör skillnaden mellan scenarierna är försäljning av överloppselektricitet, möjliga tilläggsinvesteringar och anskaffning av reservelektricitet.

NPV- och EVA-kurvorna för de två mest lönsamma scenarierna, dvs. scenario C och F, syns i grafen nedan. Man kan observera skillnaden mellan EVA och NPV i grafen. EVA är ett evalueringsverktyg som exkluderar alla typer av icke-kontanta kostnader, vilket betyder att EVA alltid ligger nedanför NPV i grafen.



Figur 1. EVA- och NPV-resultat i fallstudie 1.

7.4.2 Fallstudie 2 – Utnyttjande av oljeskiffer för produktion av cementklinker och energiproduktion

Företaget har som mål att kommersiellt utnyttja oljeskiffer för produktion av cementklinker och energiproduktion. Projektet är baserar sig på gruvarbete, el- och energiproduktion samt cementklinkerproduktionsaktiviteter. Den förbränningsteknologin som energikraftverket använder sig av heter cirkulerad fluidsbäddsteknologi (Engelska: Circulated Fluidized Bed), vilket är en av de miljövänligaste teknologierna för förbränning av fossila bränslen. Det industriella systemet har en cementanläggning som producerar cementklinker av flera olika råmaterial integrerat med en CFB-panna och en ångturbin för elproduktion. Kraftverket har en kapacitet på 30 MW och har ett kylmedelssystem som producerar ånga då oljeskiffer bränns i CFB-pannan.

Då oljeskiffer förbränns i CFB-pannan produceras både ånga för elproduktion och oljeskiffersaska som biprodukt. Oljeskiffersaskan är till sin kemiska uppbyggnad lika med Portland cement, vilket är cement som stelnas då den utsätts för vatten. Den egenskapen gör den lokala oljeskiffern mycket lämplig för produktion av cementklinker. Oljeskiffern består av organiskt och oorganiskt material, där det organiska materialet utgör ungefär 15 procent av oljeskifferstenen och producerar energi vid förbränning, medan det oorganiska materialet utgör ungefär 85 procent av oljeskifferstenen. De organiska substanserna i oljeskiffer kallas kerogen, vilket med andra ord är petrokemiskt material. De oorganiska substanserna i oljeskifferstenen bildar aska efter förbränning och den förs vidare till cementanläggningen och blandas med andra råmaterial som tex. kalksten och oljeskiffer för att producera cementklinker.

Den integrerade cementanläggningen har ett sintringssteg i slutet av processen som kräver ungefär 1400°C för att operera. Eftersom största delen av oljeskiffern är oorganiskt material, räcker inte oljeskifferns värmevärde för att värma ugnen till den krävda temperaturnivån, vilket betyder att nya bränslealternativ behövs. För att höja värmevärdet i ugnen finns det två olika alternativ: importera petroleumkoks eller producera skifferolja- och gaser genom att investera i en pyrolysenhet. Enheten utför en pyrolysprocess, där oljeskiffern pyrolyseras för att extrahera både skifferolja, skiffergas och semi-koks ur oljeskiffern. Undersökningens största frågor är ifall det är lönsammare att producera eget bränsle eller att importera petroleumkoks från utlandet. NPV och EVA kommer att användas som evalueringsverktyg för att avgöra vilket av dessa alternativ som är ekonomiskt mera lönsamt. Lösningarna för att täcka värmeenergibehoven i ugnen beskrivs nedan:

- Scenario A: Importera petroleumkoks för att täcka värmeenergibehoven i den integrerade cementanläggningens ugn.
- Scenario B: Investera i en pyrolysenhet för att producera den krävda mängden skifferolja och skiffergas som skulle täcka värmeenergibehoven i den integrerade cementanläggningens ugn.

Företaget tillhandahöll information om projektets investeringskostnader med enhetsspecifika kostnadsuppdelningar och operativa kostnader för det industriella komplexet utan scenariernas specifika operativa kostnader. Åtgärdsforskningens första skede i den här fallstudien gick ut på att studera processerna i det industriella systemet och beräkna hur mycket oljeskiffer som krävs för att producera den önskade mängden cementklinker, mängden svaveltrioxid i cementklinkern och de önskade mängderna skifferolja och skiffergaser. Eftersom skiffergas och semi-koks har mycket låga värmevärden, fokuserades i undersökningen på att producera den mängd skifferolja som täcker värmeenergibehoven i sintringsprocessen.

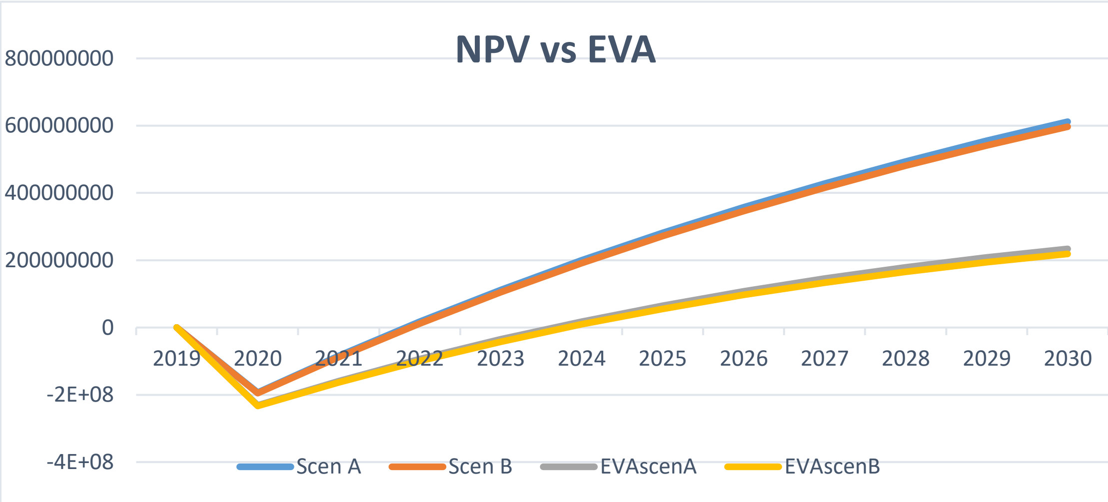
$mf_{skifferolja} = E_{värmeenergi\ behov} / H_{skifferolja}$

Den krävda mängden skifferolja fås genom att dividera värmeenergibehovet med skifferoljans värmevärde, $H_{skifferolja}$. En viss mängd oljeskiffer behövs för att kunna producera den krävda mängden skifferolja. Ekvationen nedan illustrerar hur man får den krävda mängden oljeskiffer för att producera den önskade mängden skifferolja.

$$mf_{oljeskiffer} = mf_{skifferolja} / (m\text{-}\%_{skifferolja\ i\ kerogen} * m\text{-}\%_{kerogen\ i\ oljeskiffer})$$

I den här fallstudien är den största skillnaden mellan scenarierna de operativa kostnaderna, eftersom scenario A har inköpskostnader av petroleumkoks, medan scenario B:s operativa kostnader utgörs av gruv- och transportkostnader av oljeskiffer. Denna analys görs för att veta hur mycket man kunde investera i en pyrolysenhet.

I grafen nedan presenteras båda scenariernas NPV- och EVA-resultat.



Figur 2. NPV- och EVA-resultat i fallstudie 2.

7.5 Resultat

Resultaten i denna avhandling grundar sig på teoretiska och empiriska synpunkter. Två personer i företagets ledande positioner har intervjuats för att få en bättre uppfattning om NPV och EVA som evalueringsverktyg.

Det finns flera olika faktorer som man måste ta i beaktande då man analyserar ett industriellt investeringsprojekt. Ett positivt NPV och EVA berättar inte nödvändigtvis allt om projektets natur. Den första frågan som ställdes i avhandlingen var vilka investeringsanalysverktyg som krävs för att förespå ett projekts lönsamhet. Den första personen som intervjuades svarade att målet med att evaluera projekt oftast är att locka investerare. Han påstod att NPV fungerar bra för det, eftersom man kan få en snabb skiss av hur projektets framtid kommer att se ut, medan EVA är komplicerat att beräkna innan verksamheten är igång. I början av ett projekt kan det vara svårt att erhålla bra EVA-resultat ifall det finns okända faktorer som kan påverka resultatet, medan man kan få en realistisk helhetsbild med NPV redan i planeringsskedet.

NPV berättar inte nödvändigtvis allt om projektets natur. Om man jämför EVA och NPV för scenarierna i fallstudie 2, kan man se ett stort gap mellan EVA och NPV. Det stora gapet mellan EVA och NPV är icke-kontanta kostnader som tex. avskrivningar, skattekostnader, räntekostnader och andra liknande kostnader. Å andra sidan kan EVA berätta hur stor avkastning man i verkligheten kan förvänta sig eftersom det är fråga om ren ekonomisk vinst. En investerare kan inte veta hur mycket värde investeringsprojektet skapar åt företaget eller aktieägare genom att titta på NPV, eftersom det ger ett högre värde än vad företaget egentligen får som nettoinkomst.

I både NPV och EVA är det möjligt att se ifall projekten skapar värde för företaget och aktieägarna. Problemet med NPV som evalueringsverktyg är att man inte kan mäta hur mycket aktieägarvärdet har ökat, på grund av att det finns icke-kontanta kostnader inmatade i värdet. Å andra sidan har man exkluderat alla icke-kontanta kostnader i EVA och även subtraherat resultatet med en kapitalavgift som baserar sig på kapitalförhållandet mellan eget kapital och investerarnas kapital.

7.6 Sammanfattning

Investeringsanalysverktygens uppgift är att evaluera huruvida ett projekt är lönsamt eller inte, men avhandlingen visar att EVA har flera fördelar när det kommer till att locka investerare och att beskriva projektets verkliga lönsamhet.

NPV kan också representera ekonomisk vinst, men icke-kontanta kostnader är pengar som varken aktieägare eller företaget kommer att få, vilket sammanfattningsvis visar att EVA har fördelen att beskriva ett projekts verkliga lönsamhet bättre. Ett bra exempel är Figur 7 och 8, där båda fallstudiernas scenarier presenteras med sina NPV- och EVA-resultat. Man kan se att NPV- och EVA- resultaten fallstudie 1 inte har ett stort gap mellan varandra, vilket betyder att projektet inte är finansierat så att icke-kontanta kostnader är stora. Däremot har fallstudie 2 gett olika resultat. EVA-kurvan är nästan en tredjedel av NPV-kurvan, vilket betyder att en stor del av NPV-resultatet i fallstudie 2 är icke-kontanta kostnader som varken aktieägarna eller företaget får som ekonomisk vinst.

I framtiden borde man undersöka användningen av både NPV och EVA i investeringsanalys av industriella projekt, eftersom skillnaden mellan dessa beskriver hur mycket icke-kontanta kostnader som projektet har och då kan investerare få en bättre bild av hur lönsamt ett projekt är. Genom att minska icke-kontanta kostnader kan man höja produktiviteten av ett projekt och skapa mera värde för aktieägare och företag.

NPV och EVA fungerade bra som investeringsanalysverktyg i denna avhandling, eftersom fallföretaget lyckades erbjuda industriella projekt som skiljde både i teknologi och storlek.

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