Sustainable Value Creation by Chemical Companies

Sustainable Value Research Ltd

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Foreword

Purpose and scope of this study

This study assesses the sustainability performance of nine chemical companies using the Sustainable Value approach. The Sustainable Value approach extends the concept of opportunity costs that is well established on financial markets to include environmental and social aspects. This allows for the fact that companies not only require economic capital for their business activities, but also environmental and social resources. To create positive Sustainable Value, a company must use its economic, environmental and social resources more efficiently than its market peers. This study therefore combines the concept of sustainability with the valuation methodology applied to investment and financial market decisions.

Purpose of this study is to demonstrate how efficiently various chemical companies used 13 different economic, environmental and social resources compared to their industry peers in the years 2004 to 2007. Although in theory the Sustainable Value approach could be extended to the entire life-cycle of chemical products, due to the lack of suitable environmental and social performance data this study analyses the use of different resources within the production process of the respective chemical companies. The study therefore follows the model of the financial markets that concentrate their performance assessment on the use of economic capital by the company rather than by the entire life-cycle.

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BASF SE has kindly provided financial support for this study. At the same time it must be stressed that the researchers at the Institute for Futures Studies and Technology Assessment, Queen's University Management School, Euromed Management and Sustainable Value Research Ltd. take full and sole responsibility for this study and its conclusions. At no time has BASF SE had any influence on the content or findings of this publication.

Executive Summary

This study reports the findings of a research project that analysed the sustainability performance of nine chemical companies using the Sustainable Value approach. The research was conducted by researchers working at IZT – Institute for Futures Studies and Technology Assessment in Berlin, Queen's University Management School in Belfast, Euromed Management in Marseille and Sustainable Value Research Ltd.

The Sustainable Value approach is the first method that assesses corporate sustainability performance based on the value created with the resources used. By extending a traditional valuation method applied in financial analysis, it assesses not just the use of economic capital, but also environmental and social resources. A chemical company thus creates positive (or negative) Sustainable Value if it earns a higher (or lower) return than its peers with the economic, environmental and social resources used. An analysis based on the Sustainable Value approach therefore establishes whether a company is successfully using its resources to create value in comparison to its industry peers. In doing so, the Sustainable Value approach measures corporate sustainability performance in monetary terms. It establishes a link between sustainability and the value-based approach that is traditionally used in management practice and financial analysis.

This study assess the sustainability performance of Air Liquide S.A. (Air Liquide), Akzo Nobel N.V. (AKZO), BASF SE (BASF), Bayer AG (Bayer), The Dow Chemical Company (DOW), Koninklijke DSM N.V (DSM), E. I. du Pont de Nemours and Company (DuPont), Reliance Industries Limited (Reliance) and Shell Chemicals (Shell Chemicals) over a four-year period, i.e. from 2004 to 2007. The use of 13 different economic, environmental and social resources, based on the financial, environmental and social data reported and published by the companies themselves, is evaluated. Two assessments were carried out in the process of this research: The first assessment focuses on the creation of absolute Sustainable Value. A chemical company creates positive or negative Sustainable Value if it earns a higher (or lower) return than its industry peers with its economic, environmental and social resources. The second assessment takes into account company size and is a measure of the relative sustainability performance of companies. To compare companies of different size, the return of a company using a specific bundle of resources is compared to the return that the peer group would have generated with the exact same amount of resources.

The results of the calculation of absolute Sustainable Value creation show considerable differences in sustainability performance between the companies assessed. Air Liquide and BASF not only create the highest Sustainable Value but also represent the only two companies consistently creating positive Sustainable Value over the entire review period. That is, in each of the years assessed, Air Liquide and BASF created more cash flow with their economic, social and environmental resources than their industry peers. Reliance also managed to consistently create a positive Sustainable Value for the years 2004 to 2006, however, no environmental performance data for the year 2007 were available from Reliance on completion of this study. The strongest positive performance trend among the companies assessed is shown by Bayer. While Bayer created a negative Sustainable Value in the first year asses-

sed, in the following two years Bayer made significant efficiency improvements. DuPont also managed to improve its Sustainable Value performance. While destroying Sustainable Value in 2004 and 2005, the resource bundle considered in this study was used in a value creating way in 2006 and 2007. In contrast, the performance of Shell Chemicals shows a clear downward trend. Still creating positive Sustainable value in 2004 and 2005, Shell Chemicals' resource efficiency was clearly below the peer group average in 2006. AKZO's sustainability performance assessed with the Sustainable Value approach ranges in the lower mid-field of its peer group and is subject to a fluctuant development. DOW is bringing up the rear in terms of absolute Sustainable Value creation. Just like DSM and AKZO, Dow Chemicals achieved no positive Sustainable Value during the entire review period.

The second assessment carried out in this research takes into account company size. In this assessment, Air Liquide ranks first among the companies assessed. In 2006, Air Liquide used its resources almost twice as efficiently as the peer group on average, i.e. Air Liquide created almost twice as much cash flow with its resources than the peer group on average would have generated with the same amount of resources. At the bottom of this ranking are DOW and DSM. Both companies are using their resources only nearly half as efficiently as the peer group on average.

This study provides a detailed description of the Sustainable Value approach, the methodology used to analyse the sustainability performance of nine chemical companies, and the subsequent findings, including a ranking of these chemical companies. The study closes with a detailed discussion of the results of each of the companies investigated. While the differences in sustainability performance between the companies can be partially attributed to differences in their product portfolios as well as to financial and structural effects, the individual results also reflect the effects of good environmental and social management practices. It should be noted, however, that the Sustainable Value does not attempt to express a company's entire commitment to sustainability in a single ratio. Qualitative sustainability aspects should be managed with qualitative instruments. Rather, the Sustainable Value approach provides a link between sustainability and the value-oriented approach that is common in management practice. Taken as a whole, the results of this study provide a transparent and meaningful overview of sustainability performance trends among the chemical companies assessed. The study also shows that the Sustainable Value approach is a practical tool for producing an in-depth and integrative assessment of corporate sustainability performance.

1 Introduction

Measuring corporate sustainability performance is a complex undertaking. This is not only due to the fact that economic, environmental and social information need to be considered simultaneously, but also due to problems concerning the quality and availability of the necessary data. Nevertheless, measuring corporate sustainability performance is extremely important: unless it can be measured, it cannot be managed. Traditional instruments are not capable of combining the environmental, social and economic parameters of sustainability and reporting them in a standardised form that is readily understood throughout an organisation.

The Sustainable Value approach was developed specifically to solve this problem (see for example Figge, 2001; Figge & Hahn, 2004a, 2005). Sustainable Value measures the efficient use of economic, environmental and social resources and expresses the result in a single integrated monetary figure. Sustainable Value measures the use of environmental and social resources exactly in the same way as companies currently assess the return on capital employed: In the value-oriented approach to management, it is assumed that the use of capital creates value when it earns a higher return than if the capital had been employed elsewhere. The Sustainable Value approach therefore moves away from traditional logic based on impacts and instead treats environmental and social assets as scarce resources that have to be used in a value-creating way.

The Sustainable Value approach was developed by researchers who currently work at Queen's University Belfast and Euromed Management School Marseille. It was subsequently tested in a series of research projects and case studies (Figge & Hahn, 2004b; Hahn, Figge, & Barkemeyer, 2007, 2008; Hahn, Liesen, Figge, & Barkemeyer, 2007). This report represents the first comprehensive study of the chemical sector based on the Sustainable Value approach.

The remainder of this study is structured as follows: In the next chapter we present the logic of the Sustainable Value approach and explain how it was applied for the purposes of this study. The third chapter describes the scope of the assessment in this study. We then take a look at the aggregated results (chapter 4) and discuss the results on the individual company level in chapter five. In chapter six we present our conclusions.

2 Method for Calculating Sustainable Value

2.1 *The Sustainable Value Approach in Brief*

Companies not only use economic capital but also environmental and social resources to create value. To determine a company's sustainability performance, the entire bundle of different resources used must be taken into consideration. The Sustainable Value approach measures corporate sustainability performance in monetary terms. In this sense the approach is based on a fundamental principle of financial economics: companies create value whenever they use a resource more efficiently than their peers. In the financial market, this valuation methodology has long been practised under the banner of opportunity costs.

The example illustrated below (Figure 1) explains the underlying notion of opportunity costs. Let's assume an investment, such as a share, yields an annual return of 8%. To assess whether this was a good performance, we need to compare it with a benchmark – generally the market average. Assuming that the market (e.g. the shares represented by the DAX index) has only produced an annual return of 5%, the investment has outperformed this index by 3%. This is also known as the value spread. To determine how much value has been generated by the investment, this value spread simply needs to be multiplied by the capital employed. Assuming an investment of € 100, the value spread comes to € 3 (see Figure 1).

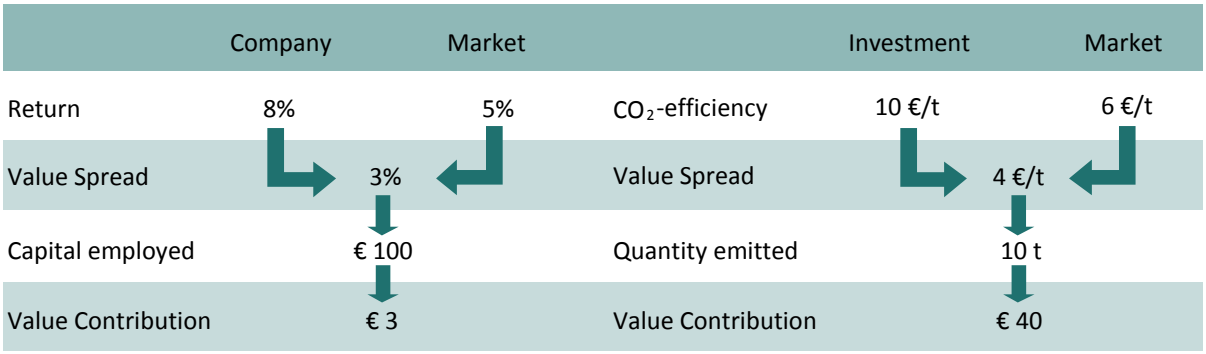

Figure 1: Value-oriented analysis of resource use

The Sustainable Value approach extends this methodology, which is firmly established in financial markets and company valuation practices, to the use of environmental and social resources by companies. Sustainable Value is created whenever a company uses its economic, environmental and social resources more efficiently than the benchmark. To calculate Sustainable Value, a company's resource efficiency is subsequently compared with that of the benchmark. A company which emits 10 t of CO_2 in order to generate a return of € 100, has a CO_2-efficiency of € 10 per ton of CO_2. If the sector average for other companies is only € 6 return per ton of CO_2, for example, the company earns € 4 more return per ton of CO_2 than the benchmark (i.e. its industry peers). With a total emission of 10 tons of CO_2, a company therefore generates € 40 value (see Figure 1).

Sustainable Value is the first approach to use the opportunity costs method to value the use of economic, environmental and social resources by a company. It is therefore an extension of the method generally used for performance assessments in financial markets, where ana-

lysis is limited to economic capital. At the same time the Sustainable Value approach is compatible with the decision-making and valuation tools used by investors and managers.

2.2 *The Valuation Logic of Sustainable Value*

From a sustainability perspective, the valuation of the company's performance must not only take into consideration the use of economic resources, but also environmental and social resources. In this context, the following rule of thumb usually applies when assessing resource use: a resource should only be used if the return generated is higher than the costs incurred. The costs of resource use therefore need to be determined.

Unfortunately, this is not a straightforward task, whether it be for economic capital or for environmental and social resources. In traditional financial economics, this problem is resolved for economic capital by using the opportunity costs approach (Bastiat, 1870; Green, 1894; Haney, 1912). Since their capital is limited, investors cannot exploit all the investment opportunities available to them at the same time. The earnings foregone from these investment alternatives are costs as far as the investor is concerned, and are referred to as opportunity costs. An investment is successful when the return of the actual investment exceeds its opportunity costs. Opportunity costs therefore represent the cost of using economic assets, such as capital.

As already mentioned, on financial markets it is generally assumed that an investment creates value whenever it is more profitable than the average rate of return available on the market. In practice in financial analysis, a stock index is commonly used as benchmark. In other words, an investment creates value whenever its return is higher than the stock index used as a benchmark. The success of investment funds is for example typically assessed like this. A fund that fails to beat the typical return of the market does not cover its cost of capital and therefore does not create, but rather destroys value.

As already emphasised, companies do not use economic capital alone, but also consume environmental and social resources. The Sustainable Value approach therefore extends beyond the financial market's one-dimensional focus on purely economic capital and also takes into account other resources when assessing company performance. At the same time, it adopts the tried and tested concept of opportunity costs. It is interesting to note that prior to the Sustainable Value approach, no other method had attempted to assess the use of environmental and social resources by applying the opportunity costs approach (Figge, 2001; Figge et al., 2004b, 2004a), even though this had first been suggested in principle more than 100 years ago (Green, 1894).

To determine the sustainability performance of companies, the costs of the economic, environmental and social resources used have to be deducted from the return earned by the company. This approach has already been followed for some time (Atkinson, 2000; Huizing & Dekker, 1992). However, the costs have traditionally been determined using methods that focus primarily on burdens (Figge & Hahn, 2004c). The key assumption here is that the costs of a resource depend on the burden that arises through the use of the resource. Despite a plethora of different approaches, putting a monetary value on these burdens is still extreme-

ly difficult (Carlsson Reich, 2005; Sonnemann, Schuhmacher, & Castells, 2000; Westman, 1977) and tends to produce not just inconsistent, but even conflicting results (Tol, 2005).

The Sustainable Value approach is the first value-based method for assessing corporate sustainability performance. This means that the costs of the use of resources are not determined on the basis of the potential damage inflicted by these resources, but on the contribution they make to creating value. The costs of resources are determined using opportunity cost thinking: i.e. the return that could have been generated from an alternative use of these environmental and social resources. The Sustainable Value approach thus applies the opportunity cost logic used in financial management to environmental and social resources. This value-oriented approach makes it far simpler to determine the costs of resource use.

2.3 *Calculating Sustainable Value*

Sustainable Value represents the value that a company creates through the use of a bundle of economic, environmental and social resources. Sustainable Value is calculated in five steps, described in detail in this section. It becomes clear that the assessment of corporate sustainability performance using the opportunity costs method is straightforward and does not involve complex mathematics.

The following five steps are necessary to calculate Sustainable Value. Each step provides the answer to a specific question that is relevant for the assessment of a company's sustainability performance.

(1) How efficiently does a company use its resources?
In this step, the efficiency of the use of various resources in the company is calculated.

(2) How efficiently does the benchmark use the resources?
In this step the benchmark is established and the efficiency of its resource use is assessed.

(3) Does the company use its resources more efficiently than the benchmark?
In this step the resource efficiency of the company is compared with that of the benchmark.

(4) Which resources are used by the company in a value-creating way?
In this step the value contribution of the various resources is determined.

(5) How much Sustainable Value does a company create?
In the final step, the task is to assess whether the company used the given set of economic, environmental and social resources to create value.

These five steps are now explained using the example of the sustainability performance of BASF in 2007.

Step 1: How efficiently does a company use its resources?

The purpose of the first step is to establish how efficiently the company uses its various economic, environmental and social resources. To this end, the quantity of resources used is compared with the return generated by the company. First, we need to establish which

parameter to use for measuring the company's profitability. To determine the sustainability performance of globally operating companies in the chemical sector, this study uses the net operating cash flow from ordinary business activities (in the following: "cash flow"). The calculation of resource efficiency is based on the cash flow generated by the company per unit of resource employed. To this end, the cash flow is divided by the quantity of resources used in each case.[1] In 2007, BASF generated a cash flow of € 5.8 billion while emitting 28.8 million metric tons of greenhouse gas (GHG) emissions. Consequently, BASF showed a GHG-efficiency of € 202 cash flow per ton of GHG emitted. When calculating the company's resource efficiency, it has to be ensured that the data on resource use are based on the same scope of consolidation as the earnings figures.

Step 2: How efficiently does the benchmark use the resources?

The second step of the analysis calculates how efficiently the benchmark uses the relevant economic, environmental and social resources. First of all the benchmark has to be defined. The benchmark for this study is constructed from the average cash flow produced per unit of resource of all companies assessed in this survey.[2] Since figures on average industry efficiency are generally not published or reported, they have to be determined based on the data available from the reports and publications of the individual companies within the sector. There are basically two ways to calculate peer group efficiency: on the one hand, it can be determined as an unweighted average. To this end, the mean value for the relevant resource efficiencies is determined for all the chemical companies studied. But this approach fails to take into consideration the difference between large companies, which consume far greater quantities of resources, and small companies. Alternatively, a weighted average can be calculated for peer group efficiency. To do this, the total cash flow generated by all companies studied is divided by the total amount of resources they have used. This approach takes into account the size differential between the companies, and is intended to replicate the peer group performance as accurately as possible. Bigger companies which also consume more resources therefore have a heavier weighting in the benchmark. This study on the Sustainable Value of companies in the chemical sector uses the second approach, i.e. a weighted peer group average. The benchmark in this study is thus the weighted average resource efficiency of all the chemical companies assessed in this survey. Consequently, the average net operating cash flow that these companies earn per unit of resource used is calculated for all resources considered. For example, the GHG-efficiency of the peer group amounts to € 154 cash flow per t of GHG-emissions in 2007.

Step 3: Does the company use its resources more efficiently than the benchmark?

This step compares the efficiency of the company to the efficiency of the peer group (benchmark). To this end, the peer group efficiency is deducted from the company efficiency. This results in the so-called value spread and describes how much more (or less) cash flow per unit of resource the company produces compared to the peer group. The value spread is calculated for each resource examined. This establishes whether the company uses the various

[1] See 3.2 for details on the economic, environmental and social resources examined in this study.
[2] See 3.1 for a list of companies examined in this study.

resources more efficiently than the peer group. The concept of opportunity costs therefore plays a pivotal role here.

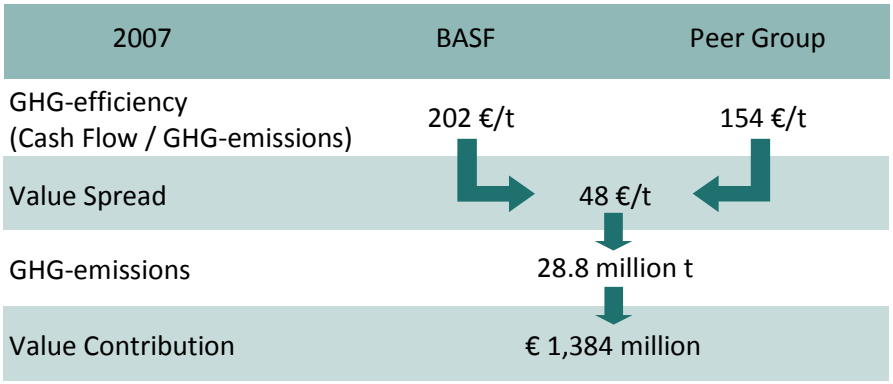

Figure 2: Calculation of the Value Contribution of BASF's GHG-emissions in 2007

The comparison of the GHG-efficiency of BASF with the benchmark shows that BASF uses this resource more efficiently than the peer group on average. BASF has a positive value spread of roughly € 48 per t of GHG-emission. In other words, BASF generates € 48 more cash flow per ton GHG emitted than the peer group average (see Figure 2). In other words, BASF exceeds the opportunity costs of its GHG-emissions by € 48 per t.

Step 4: Which resources are used by the company in a value-creating way (and which are used in a value-destroying way)?

In this step the value contribution of the various resources consumed is determined. The value spread calculated in the previous step identifies how much more (or less) cash flow *per unit of resource* the company generates compared to the benchmark. In this fourth step, the value contribution generated by *the total resource use* within the company is calculated. To this end, the relevant quantity of resources used is multiplied by the respective value spread. The result shows how much excess return the company creates with the quantity of resource used compared to the benchmark. In 2007, for example, BASF emitted 28.8 million tons of GHG. Having calculated the value spread in step three, we know that BASF creates roughly € 48 more cash flow per t of GHG than the peer group on average. If we multiply the value spread with the total quantity of GHG emitted by BASF, the resulting value contribution comes to approximately € 1.4 billion. This represents the value that is created due to that fact that BASF is emitting this quantity of GHG instead of other chemical companies (see Figure 2).

Step 5: How much Sustainable Value does a company create?

Companies do not use just one resource, but a bundle of different economic, environmental and social resources. In the previous step the value contribution of each resource was established. In this last step, we now determine how much value is being created in using the entire bundle of economic, environmental and social resources. In the previous steps, the company's entire cash flow was attributed to the use of a single resource. Obviously, this does not reflect the real situation, since the return is only produced once, through the use of

the entire resource bundle. If we were to simply add up the value contributions from the different resources, it would mean incorrectly counting a resource more than once. To be specific, if there were *n* resources the cash flow would be counted *n* times. When calculating the Sustainable Value, the sum of the value contributions is thus divided by the number of resources considered.

Figure 3 illustrates all five calculation steps. It also shows that BASF generated a Sustainable Value of roughly € 1.13 billion in 2007. The Sustainable Value expresses how much value has been created as a result of BASF using the resources in question in 2007, as opposed to other industry peers.

	Amount of resources used		Efficiency BASF [€/unit]		Efficiency Peer Group [€/unit]		Value Contribution
			①		②		④
Total assets [€]	46,802,100,000	*(	0.12	-	0.10	) =	€ 1,260,353,233
GHG-emissions [t]	28,796,434	*(	202	-	154	) =	€ 1,384,991,097
Acidification potential [t]	92,164	*(	63,010	-	44,661	) =	€ 1,691,165,436
VOC-emissions [t]	8,407	*(	690,796	-	278,064	) =	€ 3,469,705,419
Water use [m³]	275,000,000	*(	21	-	6.31	) =	€ 4,073,002,247
COD [t]	31,200	*(	186,131	-	250,518	) =	-€ 2,008,852,951
Hazardous waste [t]	589,000	*(	9,860	-	14,053	) =	-€ 2,469,972,515
Non-hazardous waste [t]	509,000	*(	11,409	-	6,638	) =	€ 2,428,316,577
Total energy use [MWh]	62,986,958	*(	92	-	47	) =	€ 2,868,869,155
Number of work accidents [nb]	366	*(	15,848,591	-	16,827,496	) =	-€ 358,964,166
Number of employees [nb]	95,175	*(	61,017	-	54,281	) =	€ 641,133,692
Research expenses [€]	1,380,000,000	*(	4.21	-	3.28	) =	€ 1,274,447,649
Personnel expenses [€]	6,648,000,000	*(	0.87	-	0.80	) =	€ 478,718,101
Sustainable Value of BASF in 2007							**€ 1,133,321,7** ⑤

Figure 3: Sustainable Value of BASF in 2007

2.4 *Making Allowances for Company Size: Return to Cost Ratio*

In financial analysis, larger companies are generally expected to generate higher profits, sales and cash flows. This size effect complicates matters when attempting to compare the performance of different companies. Financial analysis therefore compares performance parameters, such as profit or cash flow, with other indicators that reflect the size of the company. Profit, for example, is frequently assessed in relation to capital employed or sales. Meaningful analyses of companies are thus possible using key ratios such as return on capital or net profit margin.

The Sustainable Value shows, in absolute terms, how much excess return is created by a company using its resources more efficiently than the benchmark. As in traditional financial analysis, a size problem arises when attempting to compare different companies: Bigger companies generally use greater quantities of resources and therefore tend to create a bigger (positive or negative) Sustainable Value. As in financial analysis, we tackle this problem by relating the return of a company to another indicator representing the size of that company. The resulting indicator is called the Return to Cost Ratio (RCR). The Return to Cost Ratio puts the return of a company in relation to the opportunity costs of that company. It is

thus a typical benefit-cost-ratio. The opportunity costs reflect how much return could have been created, if the resources had been used in a different place. The opportunity costs of an entire bundle of resources can easily be calculated by deducting the Sustainable Value created by the company from the return generated by the company (see Figure 4).

To calculate the Return to Cost Ratio, we compare the cash flow of the company to the opportunity costs, i.e. to the cash flow the peer group would have created with the resources of the company. More precisely, we determine by which factor the cash flow of the company exceeds the opportunity costs and vice versa. Hence, the Return to Cost Ratio shows the factor by which a company uses its resources more or less efficiently than the benchmark. A RCR > 1 thus reflects that a company is using its resources more efficiently than the benchmark. A RCR < 1 shows that a company is using its resources less efficiently than the benchmark. A RCR of 1 : 2 hence shows that a company is using its resources only half as efficiently as the benchmark. Generally speaking the RCR represents a relative measure of corporate sustainability performance in relation to a benchmark.

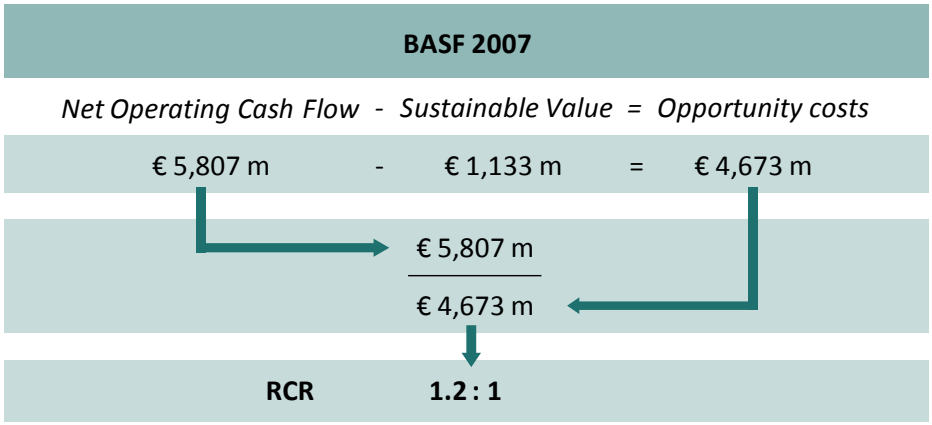

Figure 4: Calculation of the Return to Cost Ratio of BASF in 2007

Figure 4 shows that in 2007, BASF generated a cash flow that was 1.2 times higher than its opportunity costs, i.e. the cash flow that the peer group would have created with the resources used by BASF. This means that BASF used its resources 1.2 times more efficiently than the peer group on average. By comparing Return to Cost Ratios we can thus find out how much more (or less) efficiently a company uses its resources compared to other companies.

2.5 *Explanatory Power of Sustainable Value*

The Sustainable Value and the Return to Cost Ratio show how effectively a company balances profit-seeking with its environmental and social responsibilities in production. They measure how much excess return is created by a company by using a set of resources more (or less) efficiently than the benchmark. The explanatory power of the analysis depends on the choice of the benchmark. In this study, the companies assessed constitute the benchmark. The Sustainable Value therefore shows which of the companies within the set of chemical companies under analysis creates the most value using the respective economic, environmental and social resources. It provides a monetary measure of how efficiently an individual company does business compared with its peer group. The study consequently provides an analysis of selected companies within the chemical sector (best in class). It does

not provide any conclusions about the sustainability of resource use in the chemical sector compared with other industries. Therefore, the results do not allow any conclusions on whether the industry as a whole makes a contribution to a sustainable use of resources and promotes sustainable development.

Sustainable Value provides an indication of which economic, environmental and social resources are used by a company in a value-creating way, and which are not. This study does not deal with aspects outside the company. The calculation of Sustainable Value therefore does not take into consideration factors such as the performance of suppliers or product features. It also has limitations when it comes to sustainability aspects that cannot be reasonably quantified. This applies, for example, to corporate contributions to social and cultural projects. Sustainable Value calculations can only take into consideration those sustainability aspects that can be effectively quantified. The Sustainable Value does not attempt to express a company's entire commitment to sustainability in a single ratio. Qualitative sustainability aspects should be managed with qualitative instruments. Rather, the Sustainable Value approach provides a link between sustainability and the value-oriented approach that is common in management practice. The biggest advantage of Sustainable Value is therefore that it allows (a) to assess the use of environmental and social resources in the same way as the use of economic resources which (b) results in a comprehensive appraisal of sustainability performance. Company valuation and financial analysis, as well as management thinking, have traditionally focused exclusively on optimising the use of economic capital. The Sustainable Value approach extends this one-dimensional focus and applies the value-oriented approach to the assessment of the use of environmental and social resources. Sustainable Value is therefore a practical tool for measuring – and ultimately managing – a company's sustainability performance in the same way as its economic performance.

2.6 *Sustainable Value and Resource Use*

The use of resources plays a key role in sustainable development. By using environmental, social and economic resources companies have a negative impact on sustainable development. At the same time, companies require these resources to create a return and to provide goods or services to society. There is therefore a trade-off between the need to create a return and the desire to reduce the use of economic, environmental and social resources.

Sustainable development is a societal concept. Sustainable Value therefore assesses the contribution of companies to sustainable development on this higher level. To do this, Sustainable Value follows the example of the financial markets. In the financial markets the opportunity cost of capital is defined from the perspective of the providers of capital who can spread their investments across many different companies. A company creates shareholder value, i.e. value from the perspective of the investors, when it uses economic capital more efficiently than other companies. By aiming to maximise their return on investment, shareholders contribute to a more efficient use of economic capital on a higher level. Analogously, a company contributes to Sustainable Value generation when it uses resources more efficiently than other companies.

It is interesting to note that the Sustainable Value approach takes a differentiated view on the use of resources. For most other approaches in corporate sustainability assessment all resource use is considered to be negative. From the perspective of Sustainable Value it is the inefficient use of resources that is negative. An efficient use of a resource is even considered to be positive. In this context it should be kept in mind that Sustainable Value leaves the resource use on the benchmark level constant. However, Sustainable Value analyses show the potential for overall improvement by shifting resources from less efficient users to more efficient users (Figge et al., 2004c). From this perspective, it is desirable that companies with an above average resource efficiency use more resources at the expense of companies with a below average resource efficiency.

Interestingly, this also results in a differentiated view on the assessment of an increase or decrease of the use of resources. Standard management theory can once again help to explain this. It is assumed that in a market economy investors will give more capital to companies that are successful and will withdraw capital from companies that fail. This leads to an overall higher efficiency of the capital stock. Successful companies are therefore likely to use more rather than less capital in the future.

From the perspective of Sustainable Value an analogous rationale applies. Companies that use for example CO_2 more efficiently than other companies should be allocated more CO_2 in the future as this will result in a more efficient use of CO_2 on the societal level. It is important to note that the same caveat as in the financial markets applies. This increased resource use must come at the expense of a decreased resource use of less efficient resource users. In the same way in which every unit of capital can only be invested once every ton of CO_2 can also only be used once.

As Figure 5 shows, it is useful to distinguish between four cases when analysing the use of resources in the Sustainable Value approach. Both, the increase and the decrease of resource use can have a positive and negative impact on Sustainable Value.

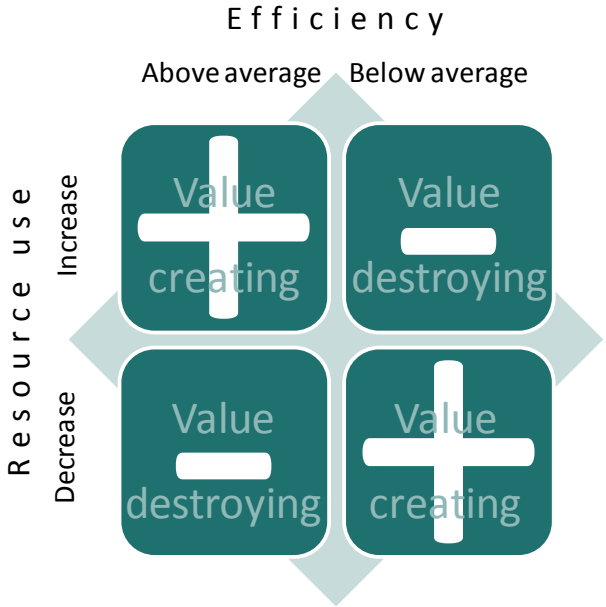

Figure 5: Sustainable Value and resource use

A higher Sustainable Value is attained by an increased resource use of a company with a higher resource efficiency than the benchmark or by a decreased resource use of a company with a resource efficiency that is below the benchmark. The latter case results in a reduction of a Sustainable Value loss. Accordingly, Sustainable Value is destroyed when inefficient companies are allocated more resources or efficient companies are allocated less resources. This also applies to social resources. Labour is a good example in this context. From the perspective of Sustainable Value a more efficient use of labour is preferable to a less efficient use. Companies that use labour more efficiently than the benchmark can increase their Sustainable Value by increasing the amount of labour they use. A reduction of employment would lead to a loss of Sustainable Value in this situation. The use of less labour will only result in a higher Sustainable Value when a company uses labour less efficiently than the benchmark. The underlying rationale is that the use of labour by efficient companies is preferable to the use of labour by companies that are less labour-efficient. The Sustainable Value therefore takes a differentiated view on the use of economic, environmental and social resources. It does not consider resource use as “bad” or “good” per se but assesses resource use based on the contribution it makes to reconciling value creation, which is desirable, to the use of scarce resources, which is undesirable.

3 Scope of the Study

This chapter describes the scope of the study. In addition to the companies studied and the indicators assessed we also take a brief look at the review period. Finally, the chapter looks at data sources used, data coverage and the treatment of missing data.

3.1 Companies Studied

This study examines the Sustainable Value of nine chemical companies, reflecting a portfolio of a broad range of activities within the chemical sector. These companies are Air Liquide S.A. (Air Liquide), Akzo Nobel N.V. (AKZO), BASF SE (BASF), Bayer AG (Bayer), The DOW Company (DOW), Koninklijke DSM N.V (DSM), E. I. Du Pont de Nemours and Company (DuPont), Reliance Industries Limited (Reliance) and Shell Chemicals (Shell Chemicals).

3.2 Indicators Assessed

One of the great strengths of the Sustainable Value approach is that it allows an integrated assessment of the use of economic, environmental and social resources by a company. For this to be possible, meaningful and quantifiable indicators need to be available on resource consumption. Thirteen different resource indicators were used in this study. These resources can be subdivided into one economic, eight environmental and four social indicators (see Table 1).

	Financial Indicator
1	Total assets in Euro
	Environmental Indicators
2	GHG-emissions in metric tons
3	Acidification potential in metric tons
4	VOC-emissions in metric tons
5	Water use in cubic meters
6	COD in metric tons
7	Hazardous waste in metric tons
8	Non-hazardous waste in metric tons
9	Total energy use in MWh
	Social Indicators
10	Number of work accidents
11	Number of employees
12	Research expenses in Euro
13	Personnel expenses in Euro

Table 1: Economic, environmental and social indicators examined in the study

We were unable to incorporate additional environmental and social aspects due to a lack of available data (e.g. the indicators particulate emissions, nitrate emissions and phosphor emissions could not be included in view of the small number of companies reporting on these indicators or the unsatisfactory quality of the data reported), or due to the difficulty in

quantifying them (e.g. social issues such as employee satisfaction, which are usually measured and managed with qualitative instruments).

As already mentioned, the return figure used for measuring profitability in this study is cash flow. We now take a brief look at the return figure and the indicators analysed in this study.

Return figure: net operating cash flow from ordinary business activities

Different return figures can be used to calculate Sustainable Value. The choice of the return figure impacts the explanatory power of the results of the assessment. This study uses the net operating cash flow from ordinary business activities as the return figure. Results consequently show how much value is created with the resources used for the owners and external lenders of capital. Compared to measures based on accounting profits, the net operating cash flow from ordinary business activities has the advantage of reflecting the business performance of the respective financial year in a very transparent way. Whereas this measure of return is not suitable for industries in which profits are made across periods, as the cash flow shows returns on an accrual basis, suitability is given in the chemical sector were barely any returns are based on cross-period activities. To calculate Sustainable Value, we therefore look at the net operating cash flow from ordinary business activities ("cash flow"). The financial performance data of the companies assessed in this survey have been mainly extracted from the data base "Bureau von Dijk". Data have been cross-checked with annual reports to make sure financial figures do not include returns from extraordinary business activities. Foreign currency figures were converted into Euros on the basis of the average annual exchange rate of the underlying financial year using www.oanda.com.

Total assets

Capital use is at the centre of traditional financial analysis. The use of capital is included in this assessment to account for the economic pillar of sustainability. The use of capital must be matched to the measure of profitability applied. Return is measured in terms of cash flow for the purposes of this study. Therefore, a corresponding broad capital figure can be chosen, i.e. it can include both on loan capital and equity capital. The use of capital in this survey is thus approximated with total assets measured in Euro.

Greenhouse gas (GHG) emissions

Greenhouse gases contribute to global warming. In this survey, we look at both, direct and indirect GHG-emissions of companies, i.e. we look at GHG-emissions that occur within the production processes and at those from the combustion of fossil fuels for the production of the electricity that is consumed during the production processes. It is possible to argue that indirect emissions occur during the production of electricity and not directly during the production processes of chemicals. For the purposes of this study, however, we decided to include indirect emissions in order to avoid any bias regarding own generation or purchase of electricity. GHG-emissions from transportation were not considered on the grounds of data availability. GHG-emission figures are given in CO_2-equivalents, measured in metric tons and comprise all kinds of greenhouse gases.

Acidification potential

Certain combustion and production processes produce sulphur oxide (SO_x) as well as nitrogen oxide (NO_x), both causing acidification of the soil and damaging forests. Along with other pollutants, NO_x and SO_x also encourage the formation of ozone at ground level (Beckert, 1999). The analysis of NO_x- and SO_x-emissions in this survey includes emissions from stationary sources, as well as emissions from own electricity generation. Transport-related emissions were not recorded. NO_x- and SO_x-emissions are summarized and expressed in equivalents of acidification potential. The acidification potential has been calculated using the factors 1.2 for SO_x and 5 for NO_x (Institute of Environmental Sciences, 2002).

Volatile organic compounds (VOC) emissions

Emissions of volatile organic compounds mainly occur during combustion processes, during production of varnishes and cleaning agents and through the use of solvents. VOC-emissions are causing smog and ground-level ozone (Beckert, 1999). We analyse direct VOC-emissions from stationary sources and did not include indirect and transport-related emissions. VOC-emissions are measured in metric tons.

Water use

Water scarcity is increasingly perceived to be an environmental and social problem throughout the world. We therefore include every type of water input, excluding the use of cooling water and water that is operated in closed-loop-cycles, in our analysis. Water use is measured in cubic meters.

Chemical oxygen demand (COD)

The removal of oxygen from water reduces its ability to sustain life. The chemical oxygen demand reflects the degree of pollution of industrial waste water with organic compounds. It describes how much oxygen is required for oxidising all organic compounds within waste water. COD is measured in metric tons in this survey.

Hazardous Waste

In this study, waste is taken into account differentiated as non-hazardous and hazardous waste. Hazardous waste in this survey covers non-reusable waste for disposal on a dry basis which is labelled as hazardous by the reporting companies. There is no harmonised legal definition of hazardous waste among different countries. We therefore cannot assure that the definitions of what is considered hazardous waste are 100% identical among the companies assessed in this survey. Hazardous waste is measured in metric tons.

Non-hazardous waste

Non-hazardous waste covers any output that is non-hazardous and goes to landfill or incineration. Waste in this survey thus does not include any outputs created during manufacturing that are to be reused or sold. In addition, we only consider non-hazardous waste from the company's ordinary business activities. This means, for example, that building rubble created

during (exceptional) remodelling of production facilities is not considered as non-hazardous waste. Non-hazardous waste is measured in metric tons on a dry basis.

Total energy use

Depending on the source of energy, energy use contributes to global warming and the depletion of natural resources. The total energy use in this survey is defined by the net energy consumption of a company, i.e. self-produced energy minus energy sold to third parties plus purchased energy from third parties. It contains energy from renewable sources and is measured in Megawatt hours (MWh).

Number of work accidents

Work place safety is an important social corporate sustainability criterion. In this survey, we assess work place safety by considering the absolute annual number of work accidents in a company. The "one-day rule" applies, i.e. every accident is counted that leads to an absence of at least one working day. The analysis covers both blue-collar and white-collar workers, but does not include accidents while commuting to or from work. As some companies only report relative figures, such as the Lost Time Injury Frequency Rate, we calculated the absolute numbers of work accidents, which are necessary for calculating Sustainable Value (see chapter 3.5.4 for more details).

Number of employees

An important part of corporate sustainability is the creation of employment. As a social indicator, this survey assesses the head count for each company based on all employees, including trainees and part-time employees. The analysis is based on annual full-time equivalents as of 31 December of each year.

Research expenses

Research is an important indicator for the persistence of corporate success in the chemical sector. The efficiency of the research expenses assessed in this survey includes all expenses for research and development and is measured in Euro.

Personnel expenses

Personnel expenses constitute a second social indicator reflecting the input of human resources in this study. It covers salaries, wages, bonus payments, social security contributions and costs for pensions. From the point of view of traditional economics labour is a (scarce) production factor. It is for this reason that we have included this indicator expressed as personnel expenses, measured in Euro.

3.3 Review Period

This study looks at the Sustainable Value of the nine chemicals companies over a four-year period from 2004 to 2007. The year 2003 had to be excluded from this assessment, as the quality of environmental performance data from the majority of the companies was insufficient.

3.4 Data Sources and Data Collection

The data used to assess the utilization of the different resources examined in the study were taken from the reports published by the individual companies. These included environmental, sustainability, CSR and integrated reports. We also referred to publications available on the companies' websites. Financial performance data were taken from the Bureau van Dijk data base and verified by examining the companies' annual reports to exclude exceptional business activities.

These data sources were used to assess the performance of the nine chemical companies over the review period. We checked and where necessary adjusted the collected data to ensure its quality, integrity and comparability (see 3.5 and Annex I: Notes on Data of the Companies under Analysis). The relevant companies were contacted directly if any ambiguities or questions arose. At this point, the companies had the opportunity to comment on the data and provide corrected or missing data. After this feedback round, the data sets for each company were prepared. These data sets were then used to calculate the Sustainable Value of the respective companies. At the same time, these data were used to calculate the average efficiency of resource use in the peer group as a whole, which then served as a benchmark for the assessment (see step 2 in chapter 2.3).

3.5 Data Coverage, Treatment of Missing Data and Data Problems

Despite intense data collection efforts, we were unable to prepare a full data set for all companies for every year of the review period. This is mainly due to the different reporting standards for environmental and social data among companies. One general point that comes to light here is that the area of environmental and social reporting, unlike traditional accounting, is still a long way from being standardised when it comes to the scope and quality of data. This section looks at data coverage for the different resource indicators (3.5.1). We then give some examples how data gaps and data problems were dealt with for the purpose of this study. More specifically, this refers to the problem of missing data (3.5.2), dealing with different scopes of consolidation (3.5.3), calculating and extrapolating data (3.5.4) and dealing with corrected data (3.5.5). A complete summary with detailed information on dealing with different scopes, assumptions, calculations and estimations made with regard to missing or incomplete data of the individual companies is attached in Annex I: Notes on Data of the Companies under Analysis.

3.5.1 Data Coverage

The following Table 2 provides an overview on the data coverage for the thirteen resources examined over the entire assessment period of this survey. It becomes evident that data coverage varies particularly in 2007. This is mainly due to Reliance and Shell Chemicals, who had not yet published their environmental performance data for that financial period at the time that the data for this assessment were gathered.

Year	Total assets	GHG-emissions	Acidification potential	VOC-emissions	Water use	COD	Hazardous waste	Non-hazardous waste	Total energy use	Number of work accidents	Number of employees	Research budget	Personnel expenses
2004	9/9	9/9	9/9	9/9	9/9	7/9	8/9	8/9	8/9	9/9	9/9	8/9	9/9
2005	9/9	9/9	9/9	9/9	9/9	7/9	8/9	8/9	8/9	9/9	9/9	8/9	9/9
2006	9/9	9/9	9/9	9/9	9/9	7/9	8/9	8/9	8/9	9/9	9/9	8/9	9/9
2007	7/9	7/9	7/9	7/9	7/9	6/9	6/9	6/9	7/9	7/9	7/9	7/9	7/9

Table 2: Data coverage

3.5.2 Treatment of Missing Data

As becomes evident in Table 2, there were no data available for some of the resources for several of the companies assessed – either for the entire review period or for specific years. If a company does not report on an indicator included in this assessment the performance of that company was set to the average performance of the companies included in this assessment, i.e. on benchmark level. In other words, it is assumed that the company does not use this resource in a value-creating way.

The missing environmental data for 2007 of Reliance and Shell Chemicals have been approximated based on the ratio of sales per resources of the year 2006. However, this estimation has only been used for constructing the benchmark and not for the company-level assessment of the respective companies. For the year 2007, accidents with more than one day sick leave have been calculated using the ratio of accidents with more than one day sick leave per employee of Reliance and Shell Chemicals in 2006 respectively.

3.5.3 Different Scopes of Data

One important step in determining Sustainable Value is the comparison of corporate resource efficiency with the benchmark efficiency (see step 3 in chapter 2.3). The calculation of these efficiencies therefore plays a central role. They are obtained by dividing the company's cash flow by the quantity of the respective resources used. In order to produce meaningful results, it is vitally important that the same system boundaries (scope) apply to the return figures and the data on resource use (United Nations Conference on Trade and Development, 2003). No meaningful comparison can be made, for example, between a cash

flow figure that applies to the entire group and a figure for water consumption that only covers part of the company (e.g. a specific division or region). Unfortunately in some cases, the environmental and social data reported by companies tend to have different system boundaries than the published financial figures.

In such cases there are two possible ways of matching up the scope for the figures available on corporate cash flow and resource use:

- One way is to reduce the scope of the financial data to match the scope of the environmental or social indicator. We can illustrate this using the example of Reliance, whose oil-exploration activities are not included in the environmental data of the company. Therefore, the business unit "oil and gas separation" (in 2006 and 2007) and "other businesses" (in 2004 and 2005) have been excluded from the financial data.
- Another way is to extrapolate the reported environmental and social data to match the scope of the companies. To do so, however, we have to assume that those divisions for which no data are available use resources with the same efficiency as those divisions for which data are reported. When compiling the study, extrapolations were undertaken on the basis of different allocation keys. One possibility is to extrapolate with the help of the company's production or sales figures. The scope of the environmental data of Air Liquide for example was stated by the company in 2004 as 89% of total sales (94% in 2005, 98% in 2006 and 2007). In consultation with Air Liquide, we extrapolated all environmental data to 100% in all years accordingly.

3.5.4 Calculating and Estimating Performance Data

In many cases companies report relative figures on the use of various resources rather than absolute figures. In such cases, the absolute performance figures have to be determined based on various estimates and assumptions. For example, a popular form of reporting of work accidents is the number of work accidents per one million hours worked (e.g. BASF, Bayer, Shell Chemicals). To come up with the absolute number of accidents, which are necessary to calculate the Sustainable Value, estimates need to be made of the average annual working hours in these companies. For the purposes of this study, we referred to the official labour market statistics published by the OECD (OECD, 2007). The projections made are based in each case on the average number of hours worked in the company's home country.

3.5.5 Dealing with Data Corrections

In one case (DOW) environmental data have been consolidated backwards to correspond to the structure of the company in 2007. Unfortunately, there are no financially backwards consolidated data available. We have decided against re-calculating any environmental or financial data, due to the fact that changes in company structure in 2007 were not significant. We acknowledge the fact that there is a slight mismatch of scopes of consolidation in this specific case.

4 Results: Overview

In this chapter we present an overview of the results of our analysis of nine chemical companies with the Sustainable Value approach. Chapter 4.1 starts with an overview of the Sustainable Value created by the companies over the period from 2004 to 2007. In chapter 4.2, we present and discuss the RCRs of the companies assessed.

4.1 Sustainable Value

Table 3 provides an overview of the absolute Sustainable Value created by the nine chemical companies during the period from 2004 to 2007, as well as the rank of each company in each year. The Sustainable Value produced by the nine companies ranges from € -2.3 billion (DOW, 2006) to € 1.6 billion (BASF, 2006). For the years 2005 to 2007 BASF generated the highest absolute Sustainable Value. If the resources employed by BASF had instead been used by an average company of the peer group between € 1.1 billion (2007) and € 1.6 billion (2006) less cash flow would have been generated with those resources. One salient feature is that two companies managed to consistently produce a positive Sustainable Value over the entire review period (Air Liquide, BASF). In the case of one other company, Reliance, no complete time series is available, but the company generated a consistently positive Sustainable Value for the years where data are available. In addition, three companies were identified as generating negative Sustainable Value over the entire review period (AKZO, DOW, DSM). The three remaining companies fluctuate around the industry average and show both positive and negative Sustainable Value figures.

	2004	*Rank*	2005	*Rank*	2006	*Rank*	2007	*Rank*
Air Liquide	€ 471,953,384	*3/9*	€ 674,591,602	*2/9*	€ 601,271,287	*3/9*	€ 888,864,430	*2/7*
AKZO	-€ 49,743,319	*5/9*	-€ 538,173,529	*6/9*	-€ 318,340,678	*7/9*	-€ 428,315,299	*5/7*
BASF	€ 1,193,373,539	*2/9*	€ 1,468,739,112	*1/9*	€ 1,649,181,720	*1/9*	€ 1,133,321,767	*1/7*
Bayer	-€ 697,782,758	*8/9*	€ 605,539,521	*3/9*	€ 938,031,553	*2/9*	€ 720,922,869	*3/7*
DOW	-€ 2,255,536,244	*9/9*	-€ 1,395,553,922	*9/9*	-€ 2,308,893,406	*9/9*	-€ 2,178,046,459	*7/7*
DSM	-€ 418,193,699	*7/9*	-€ 729,840,633	*8/9*	-€ 898,457,849	*8/9*	-€ 644,729,777	*6/7*
DuPont	-€ 168,620,438	*6/9*	-€ 631,646,807	*7/9*	€ 21,921,328	*5/9*	€ 211,871,149	*4/7*
Reliance	€ 1,487,552,136	*1/9*	€ 178,398,454	*5/9*	€ 351,888,143	*4/9*	N/A	*N/A*
Shell Chemicals	€ 436,997,397	*4/9*	€ 367,946,201	*4/9*	-€ 36,602,098	*6/9*	N/A	*N/A*

Table 3: Absolute Sustainable Value and ranking of companies

During the review period, clearly positive trends in absolute Sustainable Value are shown by Bayer (2004: € -698 million; 2007: € 721 million), Air Liquide (2004: € 472 million; 2007: € 889 million) and DuPont (2004: € -169 million; 2007: € 212 million). Also DOW shows slight improvements over time (2004: € -2.3 billion; 2007: € -2.2 billion), but ranks last over the entire assessment period. Even though BASF shows a positive trend until 2006 and leads the ranking from 2005 to 2007, its absolute Sustainable Value in 2007 dropped below 2004 levels. Companies showing a strong negative trend in their Sustainable Value include Reliance (2004: € 1.5 billion; 2006: € 352 million), Shell Chemicals (2004: € 437 million; 2006: € -37 million), AKZO (2004: € -50 million; 2007: € -428 million) and DSM (2004: € -418 million;

2007: € -645 million). These trends and the reasons behind the changes in performance are analysed in detail in chapter 5.

The graphic representation of the absolute Sustainable Value creation by the companies (Figure 6) clearly illustrates the developments discussed above. The downward trends of the performance of Reliance, Shell Chemicals, AKZO, DSM and BASF in the specific years can be seen clearly. Reliance and DSM stabilise at different levels towards the end of the respective review periods. Bayer shows the strongest positive trend. The trend is also positive for Air Liquide, which already had a positive absolute Sustainable Value as starting point. Another noticeable development is the isolated position of DOW, whose performance in the area of absolute Sustainable Value is by far the lowest among the peer group under analysis.

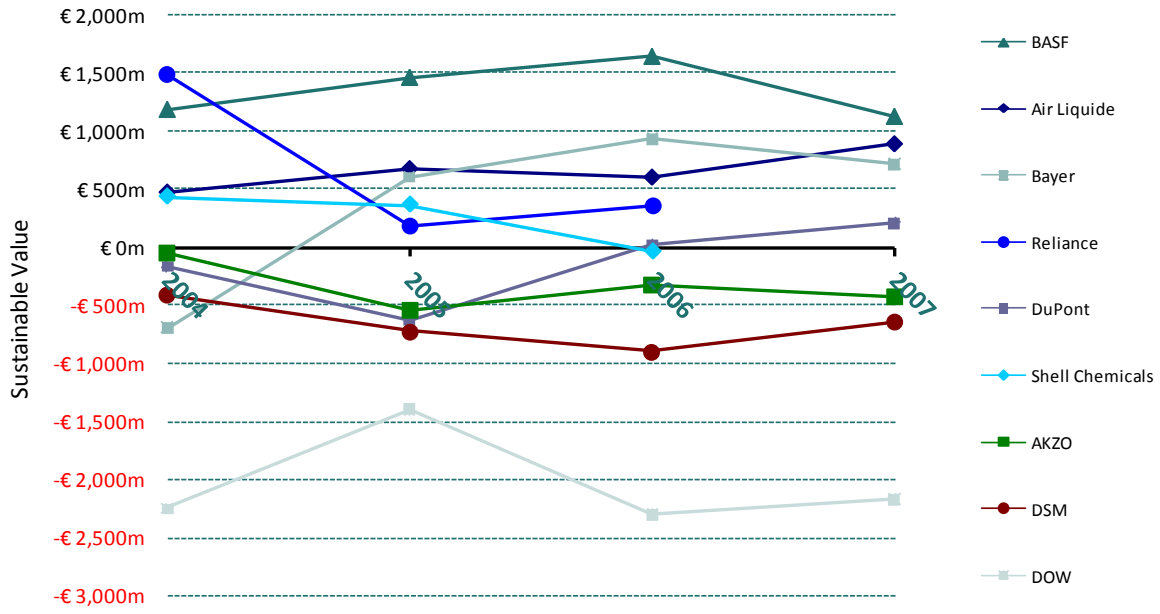

Figure 6: Absolute Sustainable Value of chemical companies

4.2 *Return to Cost Ratio*

So far the analysis of the sustainability performance focused on the absolute Sustainable Value of the individual chemical companies. As already explained in chapter 2.4, the absolute amount of Sustainable Value created is linked to the size of the company in question. The Return to Cost Ratio is a relative benefit-cost-ratio that takes into consideration the size of the company. Table 4 shows the Return to Cost Ratio, i.e. the ratio of cash flow to opportunity costs, for each of the nine companies.

Making provisions for the size of the companies allows a more meaningful comparison of the resource efficiency of the individual companies. A comparison with the results of the absolute Sustainable Value of chemical companies (Table 3) shows that the negative/positive signs are identical in each case: A company that uses its bundle of resources more efficiently than the peer group on average and thus creates a positive absolute Sustainable Value logically achieves a positive Return to Cost Ratio as well.

As with our analysis of absolute Sustainable Value, only Air Liquide and BASF thus have consistently positive Return to Cost Ratios over the entire review period; AKZO, DOW and DSM fall below the industry average in every year studied. BASF, who ranks second in absolute Sustainable Value in 2004, drops down to rank 4 when taking into account company size. With an RCR of 1.3 : 1, BASF used its resources 1.3 times more efficiently than the peer group average in that year. The least efficient company in 2004 is DOW which used its resources 2.2 times less efficiently than the peer group average (RCR 1 : 2.2). In other words, with the amount of resources with which the average company in the peer group generated a cash flow of € 1, DOW only generates about € 0.45 (1/2.2= 0.45).

	2004	*Rank*	2005	*Rank*	2006	*Rank*	2007	*Rank*
Air Liquide	1.5 : 1	*2/9*	1.6 : 1	*1/9*	1.5 : 1	*1/9*	1.7 : 1	*1/7*
AKZO	1 : 1	*5/9*	1 : 1.7	*8/9*	1 : 1.3	*7/9*	1 : 1.7	*5/7*
BASF	1.3 : 1	*4/9*	1.4 : 1	*2/9*	1.4 : 1	*2/9*	1.2 : 1	*2/7*
Bayer	1 : 1.3	*7/9*	1.2 : 1	*4/9*	1.3 : 1	*3/9*	1.2 : 1	*2/7*
DOW	1 : 2.2	*9/9*	1 : 1.4	*7/9*	1 : 1.8	*8/9*	1 : 1.8	*6/7*
DSM	1 : 1.5	*8/9*	1 : 2.1	*9/9*	1 : 2.4	*9/9*	1 : 1.8	*6/7*
DuPont	1 : 1.1	*6/9*	1 : 1.3	*6/9*	1 : 1	*5/9*	1.1 : 1	*4/7*
Reliance	2 : 1	*1/9*	1.1 : 1	*5/9*	1.2 : 1	*4/9*	N/A	*N/A*
Shell Chemicals	1.4 : 1	*3/9*	1.3 : 1	*3/9*	1 : 1	*5/9*	N/A	*N/A*

Table 4: Return to Cost Ratio and ranking of companies

Taking company size into consideration, Air Liquide is the most resource efficient company within this survey for the years 2005 (1.6 : 1), 2006 (1.5 : 1) and 2007 (1.7 : 1). In other words, in 2007 Air Liquide generated 1.7 times more cash flow with the 13 resources considered in this study than the peer group on average. Bayer and BASF both show a RCR of 1.2 : 1. This means that Bayer and BASF both generated 20% more cash flow with the resources assessed in this survey than the nine chemical companies assessed on average would have created with those resources. Apart from DuPont, which also used its resources more efficiently than the benchmark, the remaining four companies considered in this assessment all show an RCR of 1 : 1.7 and 1 : 1.8 respectively. This means that they created 41% (= 1-1/1.7) and 44% (= 1-1/1.8) less cash flow with the resources used than the other companies on average would have generated with the same set of resources.

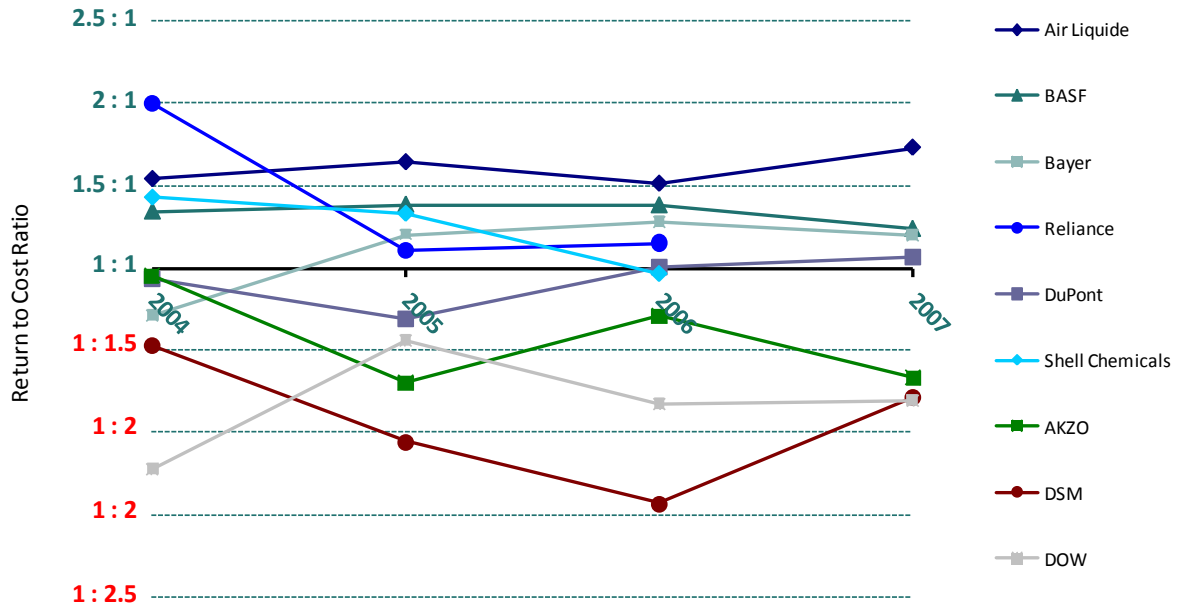

Figure 7: Return to Cost Ratio of chemical companies

The graphic presentation of the RCRs (Figure 7) illustrates the described performance patterns. In contrast to its isolated position in the absolute Sustainable Value, it can be seen that DOW uses its resources as inefficiently as DSM when company size is taken into account. The developments of the RCRs are analysed in detail for each company in chapter 5.

5 Results per Company

In chapter 5, a detailed analysis of the performance of each individual company is presented. In one case (BASF) we also provide an in-depth analysis of the performance.

5.1 BASF

BASF The Chemical Company

	2004	2005	2006	2007
Rank SV	2/9	1/9	1/9	1/7
Rank RCR	4/9	2/9	2/9	2/7

With an absolute Sustainable Value between € 1.6 billion and € 1.1 billion, BASF is the company with the highest Sustainable Value in this assessment between 2004 and 2007. In 2007, BASF used 10 out of the 13 indicators assessed in this study more efficiently than its peer group. Only the indicators COD, hazardous waste and number of work accidents had negative value contributions. For example, with the amount of COD discharged by BASF, the company created € 2 billion cash flow less than the other companies on average would have created with the same amount of COD. For the first time in 2007, BASF created less cash flow per work accident than its peers. This development is due to an increase in the number of work accidents at BASF by 28% between 2006 and 2007, which coincides with the integration of the acquired companies Engelhard, Degussa Bauchemie and Johnson Polymers.

BASF		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	€ 1,157	€ 1,665	€ 1,478	€ 1,260
	GHG-emissions	€ 872	€ 1,474	€ 1,570	€ 1,385
	Acidification potential	€ 1,313	€ 1,475	€ 1,902	€ 1,691
	VOC-emissions	€ 2,010	€ 2,790	€ 2,910	€ 3,470
	Water use	€ 3,515	€ 3,894	€ 4,085	€ 4,073
	COD	-€ 2,082	-€ 2,070	-€ 1,293	-€ 2,009
	Hazardous waste	€ 679	-€ 474	-€ 1,454	-€ 2,470
	Non-hazardous waste	€ 1,090	€ 1,832	€ 4,046	€ 2,428
	Energy use	€ 2,079	€ 2,378	€ 2,831	€ 2,869
	Number of work accidents	€ 1,118	€ 1,604	€ 1,502	-€ 359
	Number of employees	€ 1,010	€ 1,249	€ 925	€ 641
	Research expenses	€ 1,813	€ 1,970	€ 1,853	€ 1,274
	Personnel expenses	€ 941	€ 1,306	€ 1,084	€ 479
	Sustainable Value	**€ 1,193**	**€ 1,469**	**€ 1,649**	**€ 1,133**

Table 5: Value Contributions and Sustainable Value of BASF

In 2007, the resources that were used in the most efficient way at BASF compared to its peers are water use, VOC-emissions and energy. With these resources BASF created € 4 billion, € 3.4 billion and € 2.8 billion cash flow more, than if the same amount of resources had been used by the peer group. In total, BASF generated a Sustainable Value of € 1.1 billion in

2007, i.e. it created € 1.1 billion more cash flow with its resources than the other companies on average would have created with those resources.

When we adjust this assessment for company size by calculating the RCRs, we can see that in 2007 overall BASF created 1.2 times more cash flow with its resources than the peer group on average would have achieved with the same amount of resources. With a RCR of 1.2 : 1 BASF thus ranks second among the companies assessed in this survey. On indicator-level we can see in Table 6 that with a RCR of 3.3 : 1, BASF created 3.3-times more cash flow with its water used than the peer group would have created with the same amount of water. The indicator that is used the least efficiently by BASF compared to its peer group is hazardous waste. In this assessment BASF shows a RCR of 1 : 1.4, i.e. it created about 29% (= 1-1/1.4) less cash flow per ton of hazardous waste than the other companies assessed in this survey. With this hazardous-waste-performance BASF ranks in the mid-field of the nine chemical companies assessed.

BASF		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1.3 : 1	1.5 : 1	1.3 : 1	1.3 : 1
	GHG-emissions	1.2 : 1	1.4 : 1	1.4 : 1	1.3 : 1
	Acidification potential	1.4 : 1	1.4 : 1	1.5 : 1	1.4 : 1
	VOC-emissions	1.8 : 1	2.1 : 1	2 : 1	2.5 : 1
	Water use	4.1 : 1	3.9 : 1	3.2 : 1	3.3 : 1
	COD	1 : 1.4	1 : 1.4	1 : 1.2	1 : 1.3
	Hazardous waste	1.2 : 1	1 : 1.1	1 : 1.2	1 : 1.4
	Non-hazardous waste	1.3 : 1	1.5 : 1	3.1 : 1	1.7 : 1
	Energy use	1.8 : 1	1.8 : 1	1.9 : 1	2 : 1
	Number of work accidents	1.3 : 1	1.4 : 1	1.3 : 1	1 : 1.1
	Number of employees	1.3 : 1	1.3 : 1	1.2 : 1	1.1 : 1
	Research expenses	1.6 : 1	1.6 : 1	1.5 : 1	1.3 : 1
	Personnel expenses	1.3 : 1	1.3 : 1	1.2 : 1	1.1 : 1
	Return to Cost Ratio	**1.3 : 1**	**1.4 : 1**	**1.4 : 1**	**1.2 : 1**

Table 6: Return to Cost Ratios of BASF

In the following, we will analyse the development of BASF's performance with regard to the indicators GHG-emissions, VOC-emission, energy use and COD in more depth.

In-depth analysis of performance trends: Effect Analysis

In the following in-depth analysis, the drivers behind the development of the sustainability performance of BASF will be analysed.

As touched upon in chapter 2.6, the Sustainable Value and ultimately the RCR of a company are determined by four factors. These factors are the return of the company, the resource use of the company, the return of the benchmark and the resource use of the benchmark. A change in the level of any of these four factors effects a change in the sustainability performance of a company assessed with the Sustainable Value approach.

A change in the sustainability performance of a company can consequently be attributed to any or all of the following four effects: the company return effect (C_e), the company resource effect (C_r), the benchmark return effect (B_e) and the benchmark resource effect (B_r). These four effects can be isolated and quantified to explain the drivers behind the trend of a RCR from one point of time to another. The four effects are linked by multiplication, as shown in the following equation:

$$RCR_{t1} = RCR_{t0} \times C_e \times C_r \times B_e \times B_r$$

The RCR of a company at t_1 thus results from multiplying the RCR of that company at t_0 with the four effects explained above. Each effect will be discussed in detail in the following using the examples of BASF's performance on GHG-emissions, VOC-emissions, energy use and COD between the years 2004 and 2007.

The company return effect (C_e)

All other things being equal, the sustainability performance of a company expressed as RCR will rise (sink) when the company generates more (less) return. This fact is captured in the company return effect, which describes the extent to which the RCR of a company changes due to a variation of corporate return.

Using BASF as an example, we can now determine that the company return effect was the dominant driving force behind the development of the company's GHG-performance in terms of SV between 2004 and 2007. Due to an increase in cash flow from € 4.6 billion in 2004 to € 5.8 billion in 2007, BASF increased its GHG-RCR from 1.23 : 1 to 1.54 : 1, representing a C_e of 1.25. Due to a slight reduction in GHG-emissions, BASF further increased its GHG-RCR from 1.54 : 1 to 1.58 : 1, reflected by a C_r of 1.02. At the same time, the return of the benchmark increased resulting in a drop of the GHG-RCR of BASF from 1.58 : 1 to 1.28 : 1.

This development is reflected by a B_e of 0.81. Simultaneously, the GHG-emissions of the benchmark increased, causing the GHG-RCR of BASF to increase from 1.28 : 1 to 1.31, representing a B_r of 1.03. Overall, these four effects explain the slight improvement of BASF'S GHG-RCR of 1.23 : 1 in 2004 to 1.31 : 1 in 2007. The break down of the development of the GHG-performance of BASF into four effects is also shown in Figure 8 below.

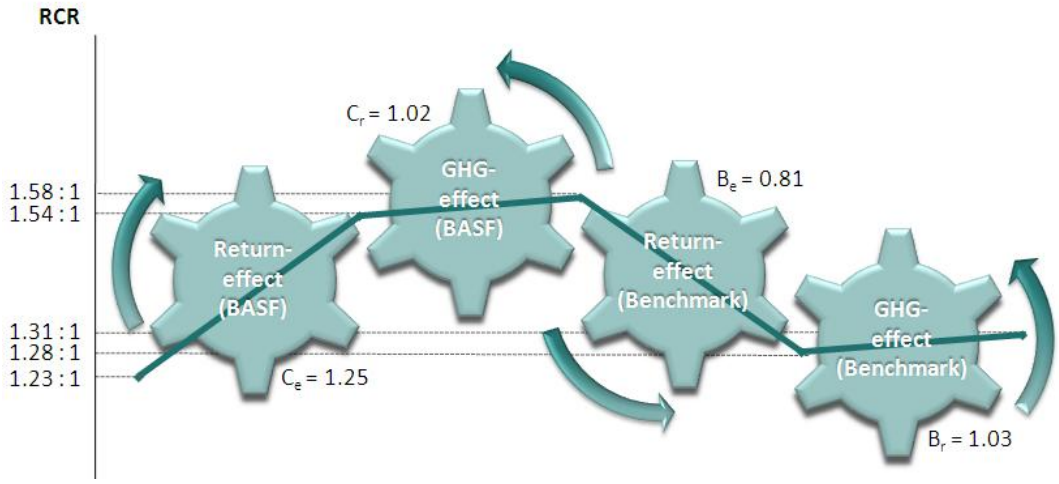

Figure 8: Development of GHG-RCR of BASF 2004 vs. 2007

The company resource effect (C_r)

Analogously to the company return effect and all other things being equal, the sustainability performance of a company measured as RCR will rise (sink) when the company reduces (increases) its resource use. The company resource effect shows to which extent the RCR of a company changes due to a variation of its resource use.

Using BASF as an example, it is now possible to determine that the company resource effect was the dominant driving force behind the development of the company's VOC-performance between 2004 and 2007. Due to the increase in cash flow discussed above, BASF's VOC-RCR rose from 1.77 : 1 to 2.21 : 1, reflected by the C_e of 1.25. Due a decrease in VOC-emissions from 12,548 tons in 2004 to 8,407 tons in 2007, BASF increased its VOC-RCR from 2.21 : 1 to 3.30 : 1, representing a C_r of 1.49. At the same time, the return of the benchmark increased (B_e = 0.81) resulting in the VOC-RCR of BASF to drop from 3.30 : 1 to 2.68 : 1. Simultaneously, the VOC-emissions of the benchmark decreased, causing the VOC-RCR of BASF to decrease from 2.68 : 1 to 2.48 : 1 (B_r = 0.93). Overall, these four effects explain the improvement of BASF'S VOC-RCR of 1.77 : 1 in 2004 to 2.48 : 1 in 2007. The break down of the development of the VOC-performance of BASF into four effects is also shown in Figure 9 below.

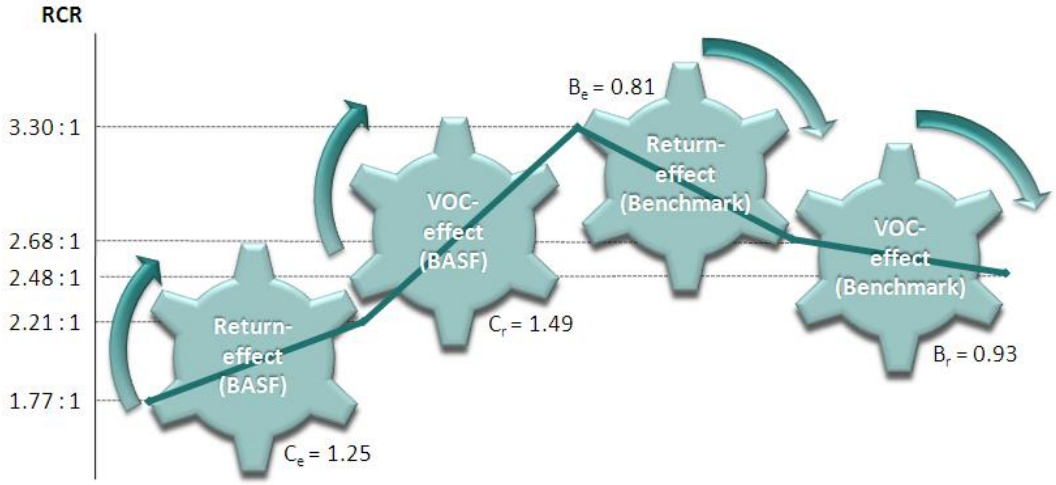

Figure 9: Development of VOC-RCR of BASF 2004 vs. 2007

The benchmark return effect (B_e)

The third influence on the development of an RCR is the return of the benchmark. All other things being equal, the sustainability performance of a company expressed as RCR decreases (increases) when the benchmark generates more (less) return. The benchmark return effect thus shows to which extent the RCR of a company changes due to a variation of the return of the benchmark.

Using BASF as an example, the benchmark return effect was the second dominant driving force behind the company's energy-use-performance between 2004 and 2007. As discussed above, BASF increased its cash flow from 2004 to 2007 (C_e = 1.25) resulting in an increased energy-use-RCR from 1.81 : 1 to 2.27: 1. At the same time, BASF also increased the amount of energy used, causing its energy-use-RCR to drop from 2.27 : 1 to 2.09 : 1 (C_r = 0.92). Simultaneously, the return of the benchmark increased from € 17.8 billion to € 22 billion, representing a B_e of 0.81 and resulting in the energy-use-RCR of BASF to decrease from 2.09 : 1 to 1.70 : 1. Due to an increase in energy use of the benchmark, the energy-use-RCR of BASF increased from 1.70 : 1 to 1.98 : 1, representing a B_r of 1.16. Overall, these four effects explain the slight improvement of BASF'S energy-use-RCR of 1.81 : 1 in 2004 to 1.98 : 1 in 2007. The break down of the development of the energy-use-performance of BASF into four effects is also shown in Figure 10 below.

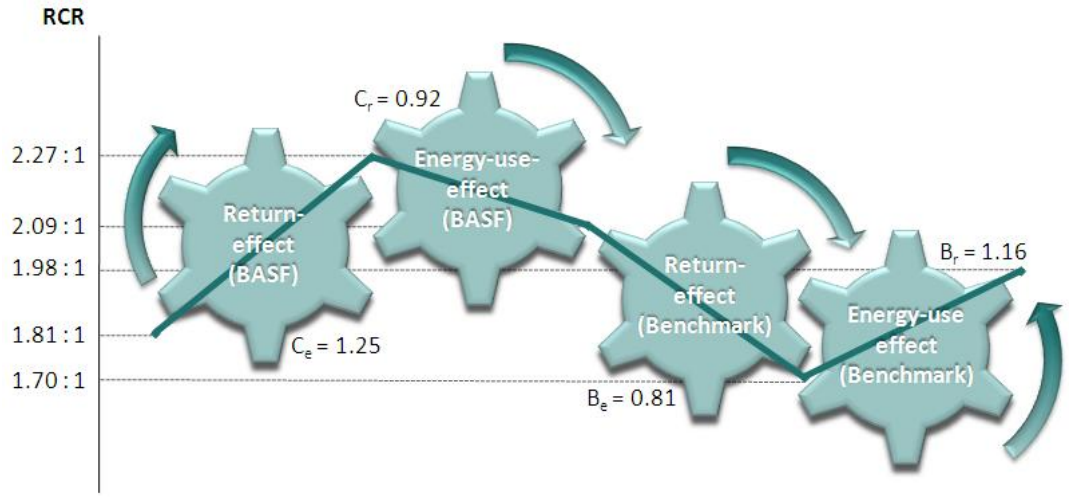

Figure 10: Development of energy-use-RCR of BASF 2004 vs. 2007

The benchmark resource effect (B_r)

The final influence on RCR is the resource use of the benchmark. All other things being equal, the sustainability performance of a company expressed as RCR will decrease (increase) when the benchmark uses less (more) resources. The benchmark resource effect thus shows to which extend the RCR of a company changes due to a variation of the resource used by the benchmark.

Using BASF as an example, the benchmark resource effect was the second dominant driving force behind the company's COD-performance between 2004 and 2007. Due to the increase in cash flow discussed above (C_e = 1.25), BASF increased its COD-RCR from a negative 1 : 1.45 to a negative 1 : 1.16. At the same time, BASF decreased the amount of COD discharged and increased its COD-RCR from a negative 1 : 1.16 to a positive 2.40 : 1, representing a C_r of 2.78. As discussed above, the return of the companies that constitute the benchmark increased (B_e = 0.75) causing the COD-RCR of BASF to drop from 2.40 : 1 to 1.81 : 1. Due to an decrease of the COD discharged by the benchmark from 176,945 tons in 2004 to 72,470 tons in 2007, the COD-RCR of BASF decreased from 1.81 : 1 to a negative 1 : 1.35, reflecting a B_r of 0.41. Overall, these four effects explain the slight improvement of BASF'S COD-RCR of 1 : 1.45 in 2004 to 1 : 1.35 in 2007. The break down of the development of the COD-performance of BASF into four effects is also shown in Figure 11 below.

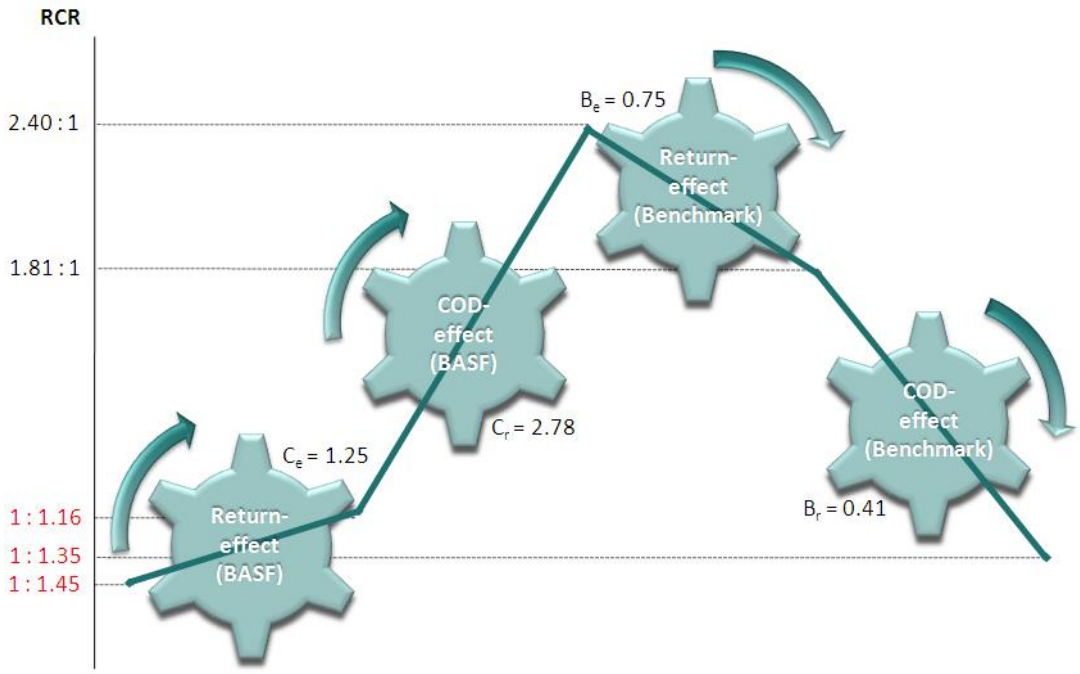

Figure 11: Development of COD-RCR of BASF 2004 vs. 2007

This in-depth analysis of the performance developments of BASF identifies the main drivers behind changes in corporate sustainability performance using the Sustainable Value approach. While similar analyses have been carried out for the other companies included in this survey during the course of this research, an in-depth analysis of their performance development does not form part of this document.

5.2 *Air Liquide*

	2004	2005	2006	2007
Rank SV	3/9	2/9	3/9	2/7
Rank RCR	2/9	1/9	1/9	1/7

Air Liquide is, next to BASF, one of the two companies that generated a positive Sustainable Value over the entire review period and ranks second (2005 and 2007) and third (2004 and 2006) among the nine companies assessed in terms of absolute Sustainable Value. The absolute Sustainable Value of Air Liquide shows a positive trend and ranges from € 472 million in 2004 to € 889 million in 2007. In other words, in 2007 Air Liquide created € 889 million cash flow more than its peer group on average would have created with the same amount of resources.

Air Liquide		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	€ 190	€ 83	€ 161	€ 325
	GHG-emissions	-€ 447	-€ 331	-€ 599	-€ 355
	Acidification potential	€ 714	€ 893	€ 1,016	€ 1,345
	VOC-emissions	€ 1,304	€ 1,675	€ 1,718	€ 2,054
	Water use	€ 1,263	€ 1,626	€ 1,634	€ 1,966
	COD	€ 1,066	€ 1,333	€ 1,401	€ 1,681
	Hazardous waste	€ 1,340	€ 1,720	€ 1,767	€ 2,102
	Non-hazardous waste	€ 1,318	€ 1,694	€ 1,734	€ 2,073
	Energy use	-€ 1,251	-€ 1,337	-€ 1,675	-€ 1,120
	Number of work accidents	-€ 315	-€ 153	-€ 630	-€ 372
	Number of employees	-€ 142	-€ 54	-€ 176	-€ 85
	Research expenses	€ 878	€ 1,213	€ 1,215	€ 1,472
	Personnel expenses	€ 217	€ 407	€ 250	€ 469
	Sustainable Value	**€ 472**	**€ 675**	**€ 601**	**€ 889**

Table 7: Value Contributions and Sustainable Value of Air Liquide

Out of 13 indicators assessed, nine indicators were used more efficiently by Air Liquide than by its peer group. Among those, the resources used most efficiently are VOC emissions, hazardous waste and non-hazardous waste, each generating a value contribution of about € 2.1 billion in 2007. The high value contributions created with these resources can be ascribed to the product portfolio of Air Liquide, which does not require large quantities of these resources. Resources that created a negative value contribution are GHG-emissions, number of work accidents, number of employees and energy use. Among those, the latter had the highest negative value contribution. With the energy used by Air Liquide in the year 2006, the peer group average would have generated about € 1.7 billion additional cash flow. The positive trend in absolute Sustainable Value is mainly due to an increase of the cash flow of about 57% from 2004 to 2007. The absolute quantities of six of the 13 resources used (GHG emissions, water use, energy use, number of employees, research expenses and personnel expenses) also increased during that period, but not in the same magnitude as the cash flow.

Taking company size into account, Air Liquide shows the highest efficiency in resource use among the companies assessed in this survey, ranking first in the years 2005 to 2007 and second in 2004.

Air Liquide		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1.2 : 1	1.1 : 1	1.1 : 1	1.2 : 1
	GHG-emissions	1 : 1.3	1 : 1.2	1 : 1.3	1 : 1.2
	Acidification potential	2.1 : 1	2.1 : 1	2.4 : 1	2.8 : 1
	VOC-emissions	36.9 : 1	38.1 : 1	36 : 1	43.6 : 1
	Water use	17.4 : 1	18.4 : 1	13.3 : 1	15.4 : 1
	COD	4.9 : 1	4.4 : 1	4.8 : 1	5 : 1
	Hazardous waste	> 100 : 1	> 100 : 1	> 100 : 1	> 100 : 1
	Non-hazardous waste	62.3 : 1	67.1 : 1	54.5 : 1	72 : 1
	Energy use	1 : 1.9	1 : 1.8	1 : 1.9	1 : 1.5
	Number of work accidents	1 : 1.2	1 : 1.1	1 : 1.4	1 : 1.2
	Number of employees	1 : 1.1	1 : 1	1 : 1.1	1 : 1
	Research expenses	2.9 : 1	3.4 : 1	3.2 : 1	3.3 : 1
	Personnel expenses	1.2 : 1	1.3 : 1	1.2 : 1	1.3 : 1
	Return to Cost Ratio	**1.5 : 1**	**1.6. : 1**	**1.5 : 1**	**1.7 : 1**

Table 8: Return to Cost Ratios of Air Liquide

With a Return to Cost Ratio of 1.7 : 1 in 2007, Air Liquide used its resources 1.7 times more efficiently than its peer group on average. In other words, Air Liquide created 70% more cash flow than the other companies of this survey would have created with the same set of resources. As Air Liquide produces hardly any hazardous waste due to the company's product range, the RCR for non-hazardous waste is very high. For the sake of readability, we have denoted the non-hazardous waste RCR as > 100 : 1 above in Table 8. Air Liquide also shows a strong non-hazardous waste, VOC-emission and water use performance. For example in 2007, Air Liquide used its water 15.4 times more efficiently than the peer group on average. Next to an increase of cash flow, this performance can be ascribed particularly to a reduction of the absolute quantity of the use of these resources. The resource used the least efficiently at Air Liquide is energy. Despite a positive trend, Air Liquide still created 34% (= 1-1/1.5) less cash flow than the peer group average would have created with the same amount of energy in 2007. Air Liquide ranks among the least energy-efficient companies assessed in this study.

5.3 AKZO

	2004	2005	2006	2007
Rank SV	5/9	6/9	7/9	5/7
Rank RCR	5/9	8/9	7/9	5/7

In terms of absolute Sustainable Value AKZO ranks between fifth (2004) and seventh place (2006) and thus shows a lower midrange performance among the companies assessed in this survey. The absolute Sustainable Value of AKZO was negative over the entire review period, ranging from € -50 million (2004) to € -538 million (2005). Out of the 13 indicators considered in this assessment, AKZO created a positive value contribution with six indicators. Most efficiently used were the resources acidification potential, water use and hazardous waste. With the latter the company generated for example € 932 million more cash flow in 2007 than the peer group would have created with the same amount of hazardous waste.

AKZO		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	-€ 79	-€ 471	-€ 152	-€ 1,227
	GHG-emissions	€ 702	€ 321	€ 654	€ 126
	Acidification potential	€ 895	€ 556	€ 842	€ 422
	VOC-emissions	-€ 15	-€ 541	-€ 280	-€ 414
	Water use	€ 908	€ 550	€ 852	€ 435
	COD	€ 806	€ 378	€ 615	€ 192
	Hazardous waste	€ 932	€ 453	€ 713	€ 432
	Non-hazardous waste	€ 590	€ 300	€ 481	€ 364
	Energy use	-€ 7	-€ 400	-€ 160	-€ 575
	Number of work accidents	-€ 1,420	-€ 2,597	-€ 2,307	-€ 2,218
	Number of employees	-€ 1,625	-€ 2,252	-€ 2,152	-€ 1,691
	Research expenses	-€ 1,262	-€ 1,793	-€ 1,725	-€ 283
	Personnel expenses	-€ 1,071	-€ 1,501	-€ 1,519	-€ 1,132
	Sustainable Value	**-€ 50**	**-€ 538**	**-€ 318**	**-€ 428**

Table 9: Value Contributions and Sustainable Value of AKZO

While many performance indicators show a negative trend from 2004 to 2007 (e.g. COD, VOC-emissions, total assets, GHG-emissions), the value contribution of research expenses increased from € -1.2 billion (2004) to € - 0.3 billion (2007). Still, in 2007 the expenses for research activities generated € 0.3 billion less cash flow than the peer group would have generated with the same amount of research expenses. When looking separately at AKZO's performance with regard to the three pillars of sustainability, it becomes apparent that the majority of negative value contributions is related to social and economic indicators, i.e. all social and economic indicators show a worse performance than the peer group average and lead to a loss of Sustainable Value. In contrast to that the environmental performance is, apart from VOC-emissions and energy use, better than the peer group average. In total, AKZO generated a negative Sustainable Value of € 428 million in 2007.

As shown in the header on the previous page, the ranking position for the years 2004, 2006 and 2007 remains the same when taking company size into account. Only in 2005 AKZO drops from sixth to eighth place. In 2005, as well as in 2007, AKZO created about 41% (= 1-1/1.7) less cash flow with its bundle of resources than the peer group on average. In other words, the average company of the benchmark would have created the same cash flow with only 59% of the resources used by AKZO. On the indicator level, it is noticeable that the RCR for non-hazardous waste increased from 2004 to 2007 – in contrast to the decreasing value contribution of this indicator during the same time period. This is due to AKZO increasing its efficiency more than the benchmark and creating less hazardous waste at the same time. What seems to be desirable on the company level is, however, not beneficial from the societal perspective that Sustainable Value is based on: from a societal perspective it would be more beneficial, if AKZO used non-hazardous waste in a value-creating way than if another company created non-hazardous waste in a value-destroying way (see chapter 2.6). Nevertheless, with the performance of non-hazardous waste in 2007, AKZO ranks second for this indicator, using the resource 2.3 times more efficiently than the peer group average. The worst performing indicator at AKZO is number of work accidents. In 2007, the peer group would have created the same cash flow with 77% less work accidents than AKZO. That is, AKZO created only 23% (= 1-1/4.4) of the cash flow the peer group average would have gained with the number of work accidents of AKZO.

AKZO		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1 : 1.1	1 : 1.6	1 : 1.1	1 : 2.9
	GHG-emissions	2.8 : 1	1.7 : 1	2.4 : 1	1.2 : 1
	Acidification potential	5.5 : 1	3.5 : 1	4.2 : 1	2.9 : 1
	VOC-emissions	1 : 1	1 : 1.7	1 : 1.3	1 : 1.6
	Water use	5.9 : 1	3.4 : 1	4.3 : 1	3.1 : 1
	COD	3.8 : 1	1.9 : 1	2.2 : 1	1.4 : 1
	Hazardous waste	6.8 : 1	2.4 : 1	2.8 : 1	3.1 : 1
	Non-hazardous waste	2.2 : 1	1.6 : 1	1.8 : 1	2.3 : 1
	Energy use	1 : 1	1 : 1.5	1 : 1.1	1 : 1.9
	Number of work accidents	1 : 2.3	1 : 4.3	1 : 3.1	1 : 4.4
	Number of employees	1 : 2.5	1 : 3.9	1 : 2.9	1 : 3.6
	Research expenses	1 : 2.2	1 : 3.3	1 : 2.6	1 : 1.4
	Personnel expenses	1 : 2	1 : 2.9	1 : 2.4	1 : 2.8
	Return to Cost Ratio	**1 : 1**	**1 : 1.7**	**1 : 1.3**	**1 : 1.7**

Table 10: Return to Cost Ratios of AKZO

5.4 *Bayer*

	2004	2005	2006	2007
Rank SV	8/9	3/9	2/9	3/7
Rank RCR	7/9	4/9	3/9	2/7

Bayer's performance changed significantly over the period of this assessment. In particular from year 2004 to 2005, Bayer jumped from the eighth to the third position in the ranking of absolute Sustainable Value performance. Bayer's Sustainable Value increased from € -698 million to € 606 million from 2004 to 2005. This performance can partially be attributed to the divestment of parts of its chemical business (Lanxess), as well as a significantly improved financial performance. While from 2005 to 2006 Bayer increased its Sustainable Value by a further 55% and changed its ranking position from third to second, its Sustainable Value decreased from 2006 to 2007 by about 23%. In total, however, Bayer managed to improve its Sustainable Value significantly over a four-year period, coming in third in 2007 and showing the strongest positive trend among the companies assessed during this study. In 2006 Bayer, created a Sustainable Value of about € 938 million, i.e. it generated € 938 million cash flow more than the benchmark would have generated with the same amount of resources. Bayer's strong development from 2004 to 2007 is on the one hand due to a remarkable increase of cash flow by about 75%. On the other hand, Bayer also achieved a significant reduction in the absolute quantity of all the resources assessed in this study with the exception of non-hazardous waste.

Bayer		2004	2005	2006	2007
		Value Contributions in million €			
	Total assets	-€ 1,237	-€ 189	-€ 1,303	-€ 709
Resources	GHG-emissions	€ 1,286	€ 2,418	€ 3,069	€ 3,116
	Acidification potential	€ 1,133	€ 2,415	€ 3,191	€ 3,197
	VOC-emissions	€ 380	€ 2,565	€ 3,382	€ 3,485
	Water use	€ 650	€ 2,746	€ 3,205	€ 3,201
	COD	€ 1,170	€ 2,633	€ 3,286	€ 2,953
	Hazardous waste	-€ 84	€ 445	€ 2,247	€ 2,864
	Non-hazardous waste	-€ 324	-€ 571	€ 372	-€ 1,227
	Energy use	€ 616	€ 2,297	€ 2,965	€ 3,095
	Number of work accidents	-€ 4,143	-€ 2,793	-€ 3,210	-€ 3,182
	Number of employees	-€ 2,584	-€ 1,103	-€ 882	-€ 1,450
	Research expenses	-€ 3,578	-€ 2,311	-€ 3,149	-€ 4,185
	Personnel expenses	-€ 2,355	-€ 681	-€ 981	-€ 1,785
	Sustainable Value	**-€ 698**	**€ 606**	**€ 938**	**€ 721**

Table 11: Value Contributions and Sustainable Value of Bayer

Having a look on the indicator level reveals that while nearly all environmental indicators show a positive performance, particularly social and economic resources are not used in a value-creating way. The resources used most efficiently by Bayer are VOC-emissions, water and acidification potential. The value contribution of hazardous waste has also improved

significantly. Bayer managed to increase the efficiency of this resource from a value contribution of € -84 million in 2004 to a value contribution of € 445 million in 2005, € 2,247 million in 2006 and € 2,864 million in 2007. In contrast, non-hazardous waste shows a negative trend, only contributing to Sustainable Value creation in 2006 and reaching a new low in 2007. These results have to be interpreted in the light of the fact that Bayer only reports non-hazardous waste figures that include waste from construction activities and contains unknown but significant levels of water. The definition of non-hazardous waste at Bayer hence is not compatible with the definition used by the other companies included in this study, which impacts its performance negatively.

Taking company size into account by calculating the Return to Cost Ratio, it shows that in 2007 Bayer managed to emit about 81% (= 1-1/5.4) less VOC than the peer group on average would have emitted in order to generate the same cash flow. Resources that are used less efficiently by Bayer than by its peer group include total assets and all social indicators covered in this assessment. For example, Bayer is creating 20% less cash flow with its total assets than the peer group on average would have generated with the same amount of total assets.

Bayer		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1 : 1.5	1 : 1.1	1 : 1.3	1 : 1.2
	GHG-emissions	2.1 : 1	3.2 : 1	3.7 : 1	3.7 : 1
	Acidification potential	1.9 : 1	3.2 : 1	4.2 : 1	3.9 : 1
	VOC-emissions	1.2 : 1	3.7 : 1	5.1 : 1	5.4 : 1
	Water use	1.4 : 1	4.6 : 1	4.2 : 1	4 : 1
	COD	1.9 : 1	4 : 1	4.6 : 1	3.2 : 1
	Hazardous waste	1 : 1	1.1 : 1	2.1 : 1	3 : 1
	Non-hazardous waste	1 : 1.1	1 : 1.2	1.1 : 1	1 : 1.3
	Energy use	1.3 : 1	2.9 : 1	3.4 : 1	3.6 : 1
	Number of work accidents	1 : 2.7	1 : 1.8	1 : 1.8	1 : 1.7
	Number of employees	1 : 2.1	1 : 1.3	1 : 1.2	1 : 1.3
	Research expenses	1 : 2.5	1 : 1.7	1 : 1.7	1 : 2
	Personnel expenses	1 : 2	1 : 1.2	1 : 1.2	1 : 1.4
	Return to Cost Ratio	**1 : 1.3**	**1.2 : 1**	**1.3 : 1**	**1.2 : 1**

Table 12: Return to Cost Ratios of Bayer

Remarkable on indicator level is that Bayer ranks first with regard to its RCR of GHG-emissions, acidification potential and energy use among the other companies assessed in the scope of this study. With the energy consumed in 2007 Bayer generates 3.6 times more cash flow than the peer group on average would have achieved with the same amount of energy. In other words, if the peer group average was to create the same cash flow, it would require 3.6 times more energy than Bayer. The main reason for the performance change of the overall RCR from 2006 to 2007 from 1.3 : 1 to 1.2 : 1 is an increase in COD-emissions. According to Bayer the deterioration of its COD-performance is due to the sub-optimal performance of a waste water treatment plant and an increase in production.

5.5 DOW

	2004	2005	2006	2007
Rank SV	9/9	9/9	9/9	7/7
Rank RCR	9/9	7/9	8/9	6/7

DOW shows by far the highest loss of absolute Sustainable Value, marking the bottom of the peer group over the four year period surveyed. The change in ranking from ninth (2004 to 2006) to seventh (2007) is simply due to the fact that Reliance and Shell Chemicals could not be considered on the company level in 2007 (cf. Annex 1). Nevertheless, a slightly positive trend can be observed in a long term perspective, i.e. from 2004 to 2007, where DOW increased its absolute Sustainable Value from € -2.3 billion to € -2.2 billion. In 2007 DOW thus created € 2.2 billion cash flow less than the benchmark on average would have created with the same amount of resources. By examining DOW's performance on the indicator level we can evaluate, which resources are mainly influencing DOW's negative results.

DOW		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	-€ 1,772	-€ 513	-€ 759	-€ 754
	GHG-emissions	-€ 3,219	-€ 2,261	-€ 3,154	-€ 3,017
	Acidification potential	-€ 3,647	-€ 2,391	-€ 4,026	-€ 2,238
	VOC-emissions	-€ 1,472	-€ 282	-€ 545	-€ 341
	Water use	-€ 12,927	-€ 13,325	-€ 15,417	-€ 16,328
	COD	€ 679	€ 804	-€ 214	-€ 984
	Hazardous waste	N/A	N/A	N/A	N/A
	Non-hazardous waste	-€ 6,380	-€ 5,394	-€ 8,291	-€ 6,362
	Energy use	€ 119	€ 1,287	€ 777	€ 991
	Number of work accidents	€ 589	€ 2,100	€ 1,520	€ 1,449
	Number of employees	-€ 59	€ 1,106	€ 577	€ 220
	Research expenses	-€ 502	€ 540	-€ 149	-€ 421
	Personnel expenses	-€ 731	€ 186	-€ 333	-€ 530
	Sustainable Value	**-€ 2,256**	**-€ 1,396**	**-€ 2,309**	**-€ 2,178**

Table 13: Value Contributions and Sustainable Value of DOW

For example in 2004, only three resources (COD, energy and number of work accidents) were used in a value-creating manner. The least value creating resources in 2004 were water, non-hazardous waste and acidification potential, with a negative value contribution of € 12.9 billion, € 6.4 billion and € 3.7 billion respectively. While the value contribution of water use decreases further in the following years, the use of non-hazardous waste and acidification potential shows an increasing value contribution from 2004 to 2005. However, any comparison of the absolute figures on DOW's value contribution of non-hazardous waste should take into consideration that, as with Bayer, DOW does not track waste on a dry base, i.e. DOW's non-hazardous waste contains unknown but significant levels of water. The indicator hazardous waste had to be excluded from this assessment and performance was set to the average performance of the companies included in this survey, since DOW does not

track hazardous waste in a way that is comparable with the definitions of the other companies assessed in this survey. Improvements from negative to positive value contributions at DOW were generated from 2004 to 2005 with the use of social resources, particularly research expenses, number of employees and personnel expenses. Other striking improvements from 2004 to 2005 were made in number of work accidents and in energy use. Both are the only resources used in a value-creating manner over the entire period surveyed. In 2006, cash flow declined by about 12% while resource use remained stable, causing a decrease in absolute Sustainable Value. Only three indicators were still creating positive value contributions in 2006. In 2007, value contributions partly showed a positive development again, leading to an overall improvement in terms of absolute Sustainable Value. Nevertheless, water was used the least value contributing in 2007 compared to the rest of the period surveyed, following a steady negative trend. DOW created € 6.3 billion less cash flow with its water use than the peer group on average would have generated with the same amount of water used. In 2007, also COD, energy use, work accidents, number of employees, research expenses and personnel expenses decreased in value contribution.

DOW		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1 : 2	1 : 1.2	1 : 1.3	1 : 1.3
	GHG-emissions	1 : 2.7	1 : 1.7	1 : 2.1	1 : 2.1
	Acidification potential	1 : 3	1 : 1.7	1 : 2.4	1 : 1.8
	VOC-emissions	1 : 1.8	1 : 1.1	1 : 1.2	1 : 1.1
	Water use	1 : 8	1 : 5.2	1 : 6.5	1 : 7
	COD	1.6 : 1	1.3 : 1	1 : 1.1	1 : 1.4
	Hazardous waste	N/A	N/A	N/A	N/A
	Non-hazardous waste	1 : 4.4	1 : 2.7	1 : 3.9	1 : 3.3
	Energy use	1.1 : 1	1.7 : 1	1.4 : 1	1.6 : 1
	Number of work accidents	1.5 : 1	2.9 : 1	2.2 : 1	2.1 : 1
	Number of employees	1 : 1	1.5 : 1	1.3 : 1	1.1 : 1
	Research expenses	1 : 1.3	1.2 : 1	1 : 1.1	1 : 1.2
	Personnel expenses	1 : 1.4	1.1 : 1	1 : 1.1	1 : 1.2
	Return to Cost Ratio	**1 : 2.2**	**1 : 1.4**	**1 : 1.8**	**1 : 1.8**

Table 14: Return to Cost Ratios of DOW

When taking into account company size, Dow moves up slightly in the ranking, though it remains the laggard in 2004. In 2004, DOW used its resources 2.2 times less efficiently than the peer group average, while in 2005, 2006 and 2007 the peer group average would have used the same resources 1.4 and 1.8 times more efficiently, respectively. Looking at the development of DOW's performance in more recent years, we can see that in 2007 only 4 indicators at DOW were used more efficiently than in 2006. The strengths of DOW in efficient resource use are in the areas of energy consumption and work place safety. With the latter DOW even ranks second among the seven companies assessed in 2007, showing a RCR of 2.1 : 1. In other words, if the peer group generated the same amount of cash flow as DOW, it would produce more than twice as many work accidents. With a RCR in energy use of 1.6 : 1 in

2007 DOW ranks third among the seven companies considered for the assessment in 2007. In contrast and as discussed above, DOW shows a dramatically poor efficiency in the use of water with a RCR of 1 : 7 in 2007. Where DOW gains a cash flow of € 0.14 per cubic meter of water consumed, the average company of the peer group would generate € 1 with the same amount of water.

5.6 *DSM*

	2004	2005	2006	2007
Rank SV	7/9	8/9	8/9	6/7
Rank RCR	8/9	9/9	9/9	6/7

The results of DSM are similarly striking to those of DOW (Table 15). In 2004, DSM only created positive value contributions with three of the 13 resources assessed in this survey (water, number of work accidents and research expenses). In the following three years, DSM did not use any of the resources considered in this survey in a value-creating way. In other words, any other company assessed in this survey created more value with any of the resources assessed than DSM. Although DSM managed to slightly improve its performance in terms of absolute Sustainable Value from 2005 to 2007, it ranks second last in every of those years.

DSM		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	-€ 46	-€ 315	-€ 364	-€ 130
	GHG-emissions	-€ 520	-€ 896	-€ 1,017	-€ 665
	Acidification potential	-€ 277	-€ 464	-€ 503	-€ 415
	VOC-emissions	-€ 1,193	-€ 1,727	-€ 1,973	-€ 2,122
	Water use	€ 95	-€ 130	-€ 245	-€ 73
	COD	-€ 2,358	-€ 3,282	-€ 3,472	-€ 1,830
	Hazardous waste	-€ 648	-€ 437	-€ 563	-€ 990
	Non-hazardous waste	-€ 410	-€ 688	-€ 1,215	-€ 715
	Energy use	-€ 153	-€ 374	-€ 449	-€ 160
	Number of work accidents	€ 246	-€ 337	-€ 550	-€ 192
	Number of employees	-€ 171	-€ 385	-€ 536	-€ 437
	Research expenses	€ 80	-€ 201	-€ 417	-€ 397
	Personnel expenses	-€ 80	-€ 253	-€ 377	-€ 255
	Sustainable Value	**-€ 418**	**-€ 730**	**-€ 898**	**-€ 645**

Table 15: Value Contributions and Sustainable Value of DSM

On the indicator level, the highest value contribution was generated in 2004 with the indicator work accidents, creating € 246 million cash flow more than its peer group average would have created with the same amount of work accidents. The least value creating resource by DSM is COD, showing a value contribution of € -3.5 billion in 2006. That means that DSM generates € 3.5 billion less cash flow with its COD than the peer group on average would have generated with the same amount of COD. In 2007, the most value creating re-

source is water, while the least value creating resource is VOC-emissions. The latter leads to a loss of Sustainable Value of about € 2.1 billion, i.e. DSM creates € 2.1 billion less cash flow than the peer group on average would have created with the same amount of VOC emitted.

The performance with regard to the Return to Cost Ratios is in line with the trend of the absolute Sustainable Value. However, DSM even falls back one position in the ranking when company size is taken into account. For 2005 to 2007, DSM shows the worst resource efficiency among all companies assessed, marking the bottom of the peer group with RCRs of 1 : 2.1 (2005), 1 : 2.4 (2006) and 1 : 1.8 (2007), respectively. The lowest RCR on indicator level is shown for COD in 2006, being used 6.5 times less efficiently than by the peer group on average. In other words, for creating the same cash flow as DSM, the peer group on average would have discharged only about 15% of COD compared to DSM. The most efficiently used resource at the end of the period surveyed is water, though it still is used 1.1 times less efficiently than by the peer group on average. In other words, the peer group would have created € 1.10 cash flow with the amount of water consumed by DSM to create € 1 cash flow.

DSM		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1 : 1.1	1 : 1.5	1 : 1.6	1 : 1.2
	GHG-emissions	1 : 1.6	1 : 2.3	1 : 2.6	1 : 1.8
	Acidification potential	1 : 1.3	1 : 1.7	1 : 1.8	1 : 1.5
	VOC-emissions	1 : 2.3	1 : 3.5	1 : 4.1	1 : 3.6
	Water use	1.1 : 1	1 : 1.2	1 : 1.4	1 : 1.1
	COD	1 : 3.6	1 : 5.7	1 : 6.5	1 : 3.2
	Hazardous waste	1 : 1.7	1 : 1.6	1 : 1.9	1 : 2.2
	Non-hazardous waste	1 : 1.5	1 : 2	1 : 2.9	1 : 1.9
	Energy use	1 : 1.2	1 : 1.5	1 : 1.7	1 : 1.2
	Number of work accidents	1.4 : 1	1 : 1.5	1 : 1.9	1 : 1.2
	Number of employees	1 : 1.2	1 : 1.6	1 : 1.9	1 : 1.5
	Research expenses	1.1 : 1	1 : 1.3	1 : 1.7	1 : 1.5
	Personnel expenses	1 : 1.1	1 : 1.4	1 : 1.6	1 : 1.3
	Return to Cost Ratio	**1 : 1.5**	**1 : 2.1**	**1 : 2.4**	**1 : 1.8**

Table 16: Return to Cost Ratios of DSM

5.7 *DuPont*

	2004	2005	2006	2007
Rank SV	6/9	7/9	5/9	4/7
Rank RCR	6/9	6/9	5/9	4/7

DuPont shows a strong positive trend in Sustainable Value creation over the period surveyed. While in 2004 DuPont showed a negative Sustainable Value (€ -169 million), in 2007 DuPont created a positive Sustainable Value of € 212 million. This positive trend was only interrupted in 2005 when Sustainable Value dropped from € -169 million to € -632 million.

With these results DuPont ranks sixth (2004), seventh (2005), fifth (2006) and fourth (2007) among the companies assessed in the scope of this study.

On the indicator level we can see that particularly the social indicators lead to a loss of Sustainable Value over the entire period surveyed (Table 17). COD and non-hazardous waste were set to a value contribution of € 0 because no information on these two resources could be gathered and these indicators were set to the benchmark efficiency in the assessment of DuPont (see chapter 3.5.2 above). DuPont's most value creating resource is water. It is also the only resource with which DuPont created a positive value contribution over the entire period of the study. The highest value contribution was created in 2007 when DuPont created € 2.9 billion more cash flow than the benchmark would have created with the same amount of water. In contrast, the five resources acidification potential, hazardous waste, number of employees, research expenses and personnel expenses were not used in a value-creating way in any of the years assessed. Among those, hazardous waste was used least value creating. In 2007 DuPont still created about € 3.5 billion less cash flow than the peer group on average would have created while generating the same amount of hazardous waste for disposal. Nevertheless, hazardous waste still shows an improvement in value contribution from 2004 to 2007, which is mainly attributed to the fact that the quantity of hazardous waste of DuPont was reduced by 18.6% from 2004 to 2005 while the benchmark's quantity of hazardous waste increased about 11% in 2005. The impact of the negative cash flow development at DuPont in 2005 was overcompensated in this way. With the positive development of the cash flow in the following years, the performance of the absolute Sustainable Value improved remarkably. In 2006, DuPont managed to further reduce the quantity of most of the resources consumed; only increasing the use of water and hazardous waste. Unfortunately, these efforts were reverted in 2007, when the quantity of GHG-emissions, acidification potential, water use, hazardous waste, energy use and number of employees increased again.

DuPont		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	-€ 213	-€ 647	€ 483	€ 712
	GHG-emissions	€ 406	-€ 216	€ 649	€ 783
	Acidification potential	-€ 185	-€ 1,065	-€ 274	-€ 548
	VOC-emissions	€ 846	-€ 32	€ 744	€ 991
	Water use	€ 2,427	€ 1,856	€ 2,747	€ 2,883
	COD	N/A	N/A	N/A	N/A
	Hazardous waste	-€ 4,628	-€ 3,184	-€ 3,829	-€ 3,511
	Non-hazardous waste	N/A	N/A	N/A	N/A
	Energy use	€ 291	-€ 370	€ 559	€ 939
	Number fo work accidents	€ 370	-€ 143	€ 1,067	€ 1,806
	Number of employees	-€ 52	-€ 920	-€ 128	-€ 122
	Research expenses	-€ 469	-€ 1,268	-€ 344	-€ 77
	Personnel expenses	-€ 986	-€ 2,222	-€ 1,390	-€ 1,102
	Sustainable Value	**-€ 169**	**-€ 632**	**€ 22**	**€ 212**

Table 17: Value Contributions and Sustainable Value of DuPont

The Return to Cost Ratios in Table 18 show that the picture of a strong positive trend is slightly blurred when considering company size. While in 2004 the resources were used about 9% (=1/1.1) less efficiently by DuPont than by the benchmark, in 2007 DuPont's efficiency is about 10% higher than the benchmark's efficiency. There is only a slight impact on the ranking when company size is taken into account. DuPont climbs from the seventh to the sixth rank in 2005. Following Air Liquide, in 2007 DuPont shows the second highest efficiency (RCR 12.4 : 1) in water use among the companies assessed. With the amount of water the peer group average needs to gain € 1 cash flow, DuPont creates a cash flow of € 12.40. In contrast, DuPont shows the worst performance with regard to hazardous waste generation. In 2007, DuPont generated 52% (= 1-1/2.1) more hazardous waste for disposal than the other companies assessed would have generated to create the same cash flow as DuPont.

DuPont		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1 : 1.1	1 : 1.3	1.2 : 1	1.3 : 1
	GHG-emissions	1.2 : 1	1 : 1.1	1.3 : 1	1.3 : 1
	Acidification potential	1 : 1.1	1 : 1.5	1 : 1.1	1 : 1.2
	VOC-emissions	1.5 : 1	1 : 1	1.3 : 1	1.5 : 1
	Water use	14.9 : 1	10.8 : 1	12.9 : 1	12.4 : 1
	COD	N/A	N/A	N/A	N/A
	Hazardous waste	1 : 2.8	1 : 2.6	1 : 2.3	1 : 2.1
	Non-hazardous waste	N/A	N/A	N/A	N/A
	Energy use	1.1 : 1	1 : 1.2	1.2 : 1	1.4 : 1
	Number of work accidents	1.2 : 1	1 : 1.1	1.6 : 1	2.4 : 1
	Number of employees	1 : 1	1 : 1.5	1 : 1	1 : 1
	Research expenses	1 : 1.2	1 : 1.6	1 : 1.1	1 : 1
	Personnel expenses	1 : 1.4	1 : 2.1	1 : 1.5	1 : 1.4
	Return to Cost Ratio	**1 : 1.1**	**1 : 1.3**	**1 : 1**	**1.1 : 1**

Table 18: Return to Cost Ratios of DuPont

5.8 Reliance

Reliance Industries Limited

	2004	*2005*	*2006*	*2007*
Rank SV	1/9	5/9	4/9	N/A
Rank RCR	1/9	5/9	4/9	N/A

The sustainability performance of Reliance ranks in the mid-field among the companies assessed. Since on completion of this survey no environmental data for the financial year 2007 was available for Reliance, an assessment on company level could not be conducted for that year. In 2004 Reliance created the highest Sustainable Value, generating € 1.4 billion cash flow more than its peer group average. However, in 2005 Reliance' Sustainable Value dropped about 88% to € 0.18 billion, then ranking fifth. This decline can mainly be ascribed to the negative development of the cash flow, which reduced by about 40% during that period. However, additionally an increased quantity in the use of various resources contributed to the remarkable drop of Sustainable Value. This refers particularly to water, research ex-

penses (nearly doubled from 2004 to 2005), personnel expenses and total assets. In 2006, the performance of Reliance again improved slightly, resulting in a slight improvement in ranking from fifth to fourth. The main reason for this development can be found in the cash flow as well. From 2005 to 2006, Reliance achieved an increase in cash flow of about 48%, even compensating the significant increase of hazardous and non-hazardous waste accumulation in 2006. At this point, it should be noted that the indicator non-hazardous waste is not 100% in line with the indicators of the other companies assessed, since Reliance has no information or estimation on non-hazardous waste for disposal, but only tracks non-hazardous waste generated including waste from construction activities. Nevertheless, the quantity of hazardous waste generated nearly doubled from 2004 to 2005, while more than three times as much non-hazardous waste was generated in 2006 than in 2005. According to Reliance this increase is mainly due to a high number of construction activities at various sites in that year.

Reliance		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	€ 1,884	€ 90	€ 559	N/A
	GHG-emissions	€ 1,424	€ 22	€ 84	N/A
	Acidification potential	-€ 204	-€ 1,713	-€ 1,965	N/A
	VOC-emissions	-€ 999	-€ 3,049	-€ 4,219	N/A
	Water use	€ 2,710	€ 1,439	€ 2,197	N/A
	COD	N/A	N/A	N/A	N/A
	Hazardous waste	€ 2,566	€ 1,499	€ 2,013	N/A
	Non-hazardous waste	€ 2,902	€ 1,699	€ 2,296	N/A
	Energy use	-€ 1,694	-€ 3,482	-€ 4,847	N/A
	Number of work accidents	€ 2,202	€ 956	€ 1,598	N/A
	Number of employees	€ 2,536	€ 1,292	€ 1,596	N/A
	Research expenses	€ 3,041	€ 1,849	€ 2,716	N/A
	Personnel expenses	€ 2,972	€ 1,718	€ 2,546	N/A
	Sustainable Value	**€ 1,488**	**€ 178**	**€ 352**	**N/A**

Table 19: Value Contributions and Sustainable Value of Reliance

In 2006, three resources were used by Reliance in a value-destroying manner, namely acidification potential, VOC-emissions and energy use. This means that the strongest improvement potentials for the resource efficiency of Reliance are linked to environmental indicators. The least value-creating resource in 2006 was energy. With a value contribution for energy of € -4.8 billion in 2006, Reliance ranks last among the companies assessed regarding energy use. Put differently, the peer group on average would have created € 4.8 billion more cash flow with the amount of energy that Reliance used. In contrast to the environmental indicators, Reliance shows the best performance among the companies assessed in using the four social resources included in this assessment. With its amount of personnel expenses for example, Reliance created about € 2.5 billion more cash flow than the benchmark would have created with the same amount of personnel expenses, even though the absolute quan-

tity of personnel expenses nearly doubled from 2005 to 2006. The latter can mainly be ascribed to an increase in the number of employees of almost 100%.

The ranking positions of Reliance remain unchanged after adjusting the results for company size. Nevertheless, on the indicator level changes within the performance development of some resources become evident. Particularly the difference of the RCR of non-hazardous waste is remarkable. While in 2005, Reliance still gained 26.8 times more cash flow than the peer group on average would have created with the same amount of non-hazardous waste, in 2006 Reliance only gained 8.5 times more cash flow than the other companies assessed. Notwithstanding this performance drop, Reliance ranks second after Air Liquide in the efficiency of non-hazardous waste use. The strong development of this indicator over the years, however, also nurtures the speculation of improvements or changes in the data gathering process of Reliance. Looking at the RCRs on the indicator level we furthermore see that the social indicators number of employees, research expenses and personnel expenses are subject to a continuous negative trend. Whereas research expenses for example in 2004 still showed an RCR of 98.6 : 1, in 2005 it dropped to an RCR of 30.2 : 1 and reached its lowest level in 2006, showing an RCR of 16.1 : 1. Reliance still remains undisputed first among the companies assessed in the efficient use of research expenses and personnel expenses. However, after taking account company size Reliance ranks second with the number of employees and number of work accidents.

Reliance		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	2.7 : 1	1.1 : 1	1.3 : 1	N/A
	GHG-emissions	1.9 : 1	1 : 1	1 : 1	N/A
	Acidification potential	1 : 1.1	1 : 2	1 : 1.8	N/A
	VOC-emissions	1 : 1.3	1 : 2.7	1 : 2.6	N/A
	Water use	11.5 : 1	5.4 : 1	6.4 : 1	N/A
	COD	N/A	N/A	N/A	N/A
	Hazardous waste	7.4 : 1	6.6 : 1	4.4 : 1	N/A
	Non-hazardous waste	45 : 1	26.8 : 1	8.5 : 1	N/A
	Energy use	1 : 1.6	1 : 3	1 : 2.9	N/A
	Number of work accidents	3.9 : 1	2.2 : 1	2.6 : 1	N/A
	Number of employees	5.7 : 1	3.1 : 1	2.2 : 1	N/A
	Research expenses	98.6 : 1	30.2 : 1	16.1 : 1	N/A
	Personnel expenses	30.7 : 1	9.9 : 1	8.3 : 1	N/A
	Return to Cost Ratio	**2 : 1**	**1.1 : 1**	**1.2 : 1**	**N/A**

Table 20: Return to Cost Ratios of Reliance

5.9 *Shell Chemicals*

	2004	2005	2006	2007
Rank SV	4/9	4/9	6/9	N/A
Rank RCR	3/9	3/9	5/9	N/A

As with Reliance, for Shell Chemicals no data for a meaningful company assessment was available for 2007. Also, no data could be gathered for the indicators energy use and research expenses and the performance of these indicators was consequently set to the peer group average (see chapter 3.5.2). As shown in Table 21 Shell Chemicals' Sustainable Value follows a strong negative trend over the years 2004 to 2006. In 2004, Shell Chemicals ranks fourth with a Sustainable Value of € 437 million. Still keeping its ranking position, we can see a slight drop to a Sustainable Value about € 368 million in 2005. Shell Chemicals' resource efficiency significantly decreased in the following year, creating a negative Sustainable Value about € -37 million and dropping to sixth in the ranking. This drop is partially due to a decline of the cash flow of about 25% in 2006, while there was still a slight growth in 2005. Also an increased use of the resources total assets, GHG-emissions, acidification potential as well as hazardous and non-hazardous waste contributed to this development. The performance development is reflected in more detail on the indicator level. In 2004 and 2005, only three of the eleven indicators assessed created a negative value contribution, namely GHG-emissions, VOC-emissions and hazardous waste. For the latter as well as for non-hazardous waste, it should be noted that the indicators are not 100% in line with the indicators of other companies in this assessment, since Shell Chemicals does not track waste for disposal but only waste generated.

Shell Chemicals		2004	2005	2006	2007
		Value Contributions in million €			
Resources	Total assets	€ 116	€ 297	-€ 104	N/A
	GHG-emissions	-€ 504	-€ 531	-€ 1,256	N/A
	Acidification potential	€ 258	€ 294	-€ 185	N/A
	VOC-emissions	-€ 860	-€ 1,399	-€ 1,738	N/A
	Water use	€ 1,360	€ 1,343	€ 942	N/A
	COD	€ 720	€ 204	-€ 323	N/A
	Hazardous waste	-€ 156	-€ 20	-€ 894	N/A
	Non-hazardous waste	€ 1,214	€ 1,127	€ 576	N/A
	Energy use	N/A	N/A	N/A	N/A
	Number of work accidents	€ 1,355	€ 1,363	€ 1,010	N/A
	Number of employees	€ 1,087	€ 1,067	€ 776	N/A
	Research expenses	N/A	N/A	N/A	N/A
	Personnel expenses	€ 1,093	€ 1,040	€ 720	N/A
	Sustainable Value	**€ 437**	**€ 368**	**-€ 37**	**N/A**

Table 21: Value Contributions and Sustainable Value of Shell Chemicals

In 2006, only five of the eleven indicators assessed created a positive value contribution. The least value-creating resource during the period assessed was VOC emissions. With the VOC

emitted by Shell Chemicals in 2007, € 1.7 billion more cash flow would have been created by the peer group on average. Furthermore, we can see that social resources were used most value-creating. Though subject to a negative trend as well, among those resources number of work accidents created the highest value contribution over the period surveyed.

When company size is taken into account, Shell Chemicals slightly moves up the ranking to the third (2004 and 2005) and fifth (2006) rank, respectively. In 2004 and 2005, Shell Chemicals still managed to use its resources about 40% (RCR 1.4 : 1) and 30% (RCR 1.3 : 1) more efficiently than the other chemical companies assessed in this study. In contrast, in 2006 Shell Chemicals used its resources just as efficiently as the peer group on average (RCR 1 : 1). The indicator number of work accidents shows the highest RCR. In comparison to the other companies, Shell Chemicals shows the highest efficiency regarding number of work accidents during the entire period of the study. In 2006 for example, Shell Chemicals managed to have about 92% (RCR 13.3 : 1) less work accidents than the benchmark would have had in order to gain the same cash flow as Shell Chemicals. With an RCR of 2.9 : 1 Shell Chemicals also ranks first among the companies assessed in terms of efficiency related to number of employees in the year 2006. That is, the peer group average would have needed nearly three times more employees to generate the same cash flow as Shell Chemicals. In other words, Shell Chemicals needs only about 35% of the number of employees that would be needed by the other chemical companies assessed in the scope of this study in order to gain the same cash flow. Among the use of environmental resources Shell Chemicals uses GHG- and VOC-emissions the least efficiently. The company created 2.2 and 2.6 times less cash flow with these resources than the peer group on average would have created with the same amount of GHG- and VOC-emissions.

Shell Chemicals		2004	2005	2006	2007
		Return to Cost Ratios			
Resources	Total assets	1.1 : 1	1.3 : 1	1 : 1.1	N/A
	GHG-emissions	1 : 1.4	1 : 1.4	1 : 2.2	N/A
	Acidification potential	1.2 : 1	1.3 : 1	1 : 1.2	N/A
	VOC-emissions	1 : 1.6	1 : 2	1 : 2.6	N/A
	Water use	17.9 : 1	12.2 : 1	7.3 : 1	N/A
	COD	2 : 1	1.2 : 1	1 : 1.3	N/A
	Hazardous waste	1 : 1.1	1 : 1	1 : 1.8	N/A
	Non-hazardous waste	6.4 : 1	4.4 : 1	2.1 : 1	N/A
	Energy use	N/A	N/A	N/A	N/A
	Work accidents	16.8 : 1	14.6 : 1	13.3 : 1	N/A
	Number of employees	4.1 : 1	3.7 : 1	3.5 : 1	N/A
	Research expenses	N/A	N/A	N/A	N/A
	Personnel expenses	4.1 : 1	3.5 : 1	2.9 : 1	N/A
	Return to Cost Ratio	**1.4 : 1**	**1.3 : 1**	**1 : 1**	**N/A**

Table 22: Return to Cost Ratios of Shell Chemicals

6 Conclusions and Outlook

In this study, we have assessed the Sustainable Value creation of nine globally operating chemical companies. Following a number of successful applications, this study underlines the practicability of the Sustainable Value approach for comprehensively assessing corporate sustainability performance. A major advantage of this approach is given by the combination of corporate sustainability assessment with traditionally value-based financial performance analysis. Here lies the major difference to other methods measuring corporate sustainability. Other approaches usually evaluate resource consumption in a burden-based way. Sustainable Value, in contrast, measures the value generated with the resources used, including economic, environmental as well as social resources. Sustainable Value is expressed as a monetary measure and is based on opportunity cost thinking. This means that the cost of using resources is determined by the return that would have been created with the same type and amount of resources had they been used in an alternative way. A chemical company thus creates positive (or negative) Sustainable Value if it earns a higher (or lower) return than its industry peers with its available economic, environmental and social resources. To compare companies of different sizes, the return figure is divided by the opportunity cost in order to produce the so called Return to Cost Ratio. This ratio shows by which factor a company exceeds or falls short of the resource efficiency of its industry peers.

In this study the use of 13 different economic, environmental and social resources of nine chemical companies has been rated over the four-year period from 2004 to 2007 using the Sustainable Value approach. The companies assessed in this study are Air Liquide, AKZO, BASF, Bayer, DOW, DSM, DuPont, Reliance and Shell Chemicals. The specific results show considerable differences in the sustainability performance among the companies assessed.

It is remarkable that only two companies, namely Air Liquide and BASF, managed to create a positive Sustainable Value over the entire four-year period, i.e. these two companies used their economic, environmental and social resources more efficiently than the peer group, and thus in a value creating way, in all the fours years. Except for 2004, Air Liquide and BASF are best in class. While in terms of absolute Sustainable Value creation BASF ranks first and Air Liquide second, the result is reversed when company size is taken into account by calculating the Return to Cost Ratios. In 2006, BASF achieved a Sustainable Value of € 1.6 billion – by far the highest absolute Sustainable Value among all chemical companies assessed during the four-year period. Taking into account company size, BASF used its resources 1.4 times more efficiently than its industry peers in 2006. Air Liquide, in contrast, managed to use its resources 1.5 times more efficiently than the benchmark in 2006 and even 1.7 times more efficiently in 2007. The only other company that constantly generated a positive Sustainable Value is Reliance. Ranking first in terms of absolute Sustainable Value creation in 2004, the performance of Reliance recorded a sharp performance drop from 2004 to 2005, followed by a slight improvement in 2006. Just as with Shell Chemicals, no assessment of the company's performance could be undertaken for the year 2007 since sustainability data had not been published by the company on completion of this study.

The strongest positive trend can be observed with the results of Bayer. In 2004, Bayer created a negative Sustainable Value of about € 670 million and used its resources 1.3 times less

efficiently than the benchmark. In 2005 however, following the divesture of Lanxess, Bayer's resource efficiency increased remarkably, resulting in a positive Sustainable Value. The positive trend continued in 2006, coming in second in terms of absolute Sustainable Value and third based on an assessment of the RCR. Although a slight drop can be observed for 2007, Bayer still used its resources 20% more efficiently than the peer group on average.

The worst sustainability performance among the companies assessed in this survey is shown by DSM and DOW. Following a negative trend from 2004 to 2006, DSM used its resources 2.4 times less efficiently than the peer group on average in 2006. The laggard in terms of absolute Sustainable Value creation is DOW, destroying Sustainable Value of about € 2.25 billion in 2004 and € 2.3 billion in 2006, respectively. Just as with DSM and DOW, AKZO also created a negative Sustainable Value in each of the years assessed in this survey. While in 2004 AKZO still had a negative Sustainable Value relatively close to 0, i.e. was nearly as efficient as its peer group, in 2005 AKZO's resource efficiency decreased remarkably, then being 1.7 times less efficient than the other companies on average.

Shell, Bayer, and DuPont ranked in the midfield of the chemical companies assessed in this survey. While the resource efficiency of DuPont was subject to a positive trend, Shell Chemicals' sustainability performance became worse each year. In 2004 for example, Shell Chemicals still created a positive Sustainable Value about € 437 million, using its resource bundle 1.4 times more efficiently than the benchmark. In 2006 in contrast Shell destroyed Sustainable Value of about € 37 million.

This assessment has generated valuable results. Firstly, it created transparency regarding the resource efficiency of different companies in the chemical sector. In addition, the results can be used as a starting point for sustainability management, for example for strategic target setting or sustainable investment analysis. And despite the fact that the differences in the performances of the companies assessed partially stem from differences in the product portfolio, the effect of good environmental management can clearly be seen in the results.

At this point, it should be highlighted that data availability and data consistency are playing a crucial role with respect to a comprehensive and verifiable comparison of the companies' sustainability performance. The analysis performed in this study is based on publicly available data and information provided by the companies themselves. In this regard, the biggest challenge in applying the Sustainable Value approach in this study consisted in the differences in data availability and data quality between the companies assessed. This particularly applies to environmental and social data provided. As a consequence, some areas could not be fully covered or could only be considered with the help of estimations and approximations. Nevertheless, the Sustainable Value approach proved to be a robust and meaningful analysis tool providing informative and comparative results on the sustainability performance of companies. Here too, the basic principle is: the better the data base, the more meaningful and robust the results of the analysis. As the results of this study have shown, companies vary not just in respect of their sustainability performance, but also in terms of scope and quality of their sustainability reporting. Most of the chemical companies assessed in this study have based their reporting on sustainability topics on GRI (Global Reporting Initiative) sustainability reporting guidelines. However, a detailed analysis of the sustainability reporting of chemical companies shows that there is still a lot of room for improve-

ment. Only some companies publish figures that are suitable for a direct comparison with other companies. Most of the corporate data published have to be subsequently corrected. It is common knowledge from financial reporting that adjustments occasionally need to be made to published data in order to ensure comparability. Nevertheless, sustainability reporting has some catching up to do with financial reporting. The environmental and social data from most sustainability reports still do not cover the company's entire operations. Some corporations choose to exclude parts of the business with a high environmental impact, for example.

A more standardised and harmonised environmental and social reporting in the chemical industry would therefore be highly appreciated. Particularly crucial in this respect are the standardisation of data definitions (e.g. for waste and work accident statistics) and greater consistency and transparency in the scope of data in order to ensure comparability and comprehensive coverage of the companies' global activities. The minimum objective here should be to guarantee the same scope of coverage for financial, environmental and social data.

The Sustainable Value approach applies the logic of financial management to sustainability management. Financial management theory states that the use of capital must cover its opportunity costs. In many instances the need to maximise shareholder value is a common conclusion. This is justified by the fact that an economic benefit ought to be produced. But companies obviously do not only need economic capital, but environmental and social resources as well. Because these resources are scarce, it makes sense to use them efficiently not just in order to protect the natural environment, but also to optimise the economic benefit.

If we follow the logic of financial management, companies that do not create shareholder value could see their existence threatened. From a market economy viewpoint, this microeconomic threat helps to avoid macroeconomic harm, namely the inefficient use of the valuable resource economic capital. From a sustainability viewpoint, a perspective that only focuses on economic capital has its shortcomings. The inefficient use of environmental and social resources also has the potential to produce macroeconomic damage. Applying market economy thinking, a low Sustainable Value, i.e. the inefficient use of economic, environmental and social services, would therefore pose a potential threat to a company's existence. Companies wishing to counter this threat need to create Sustainable Value. In doing so, they encourage an allocation of resources that is not only in their self-interest, but benefits the economy as a whole.

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Annex I: Notes on Data of the Companies under Analysis

Notes on Data of Air Liquide

- The scope of environmental data was stated by the company in 2004 as covering 89% of total sales (94% in 2005, 98% in 2006 and 2007). In consultation with Air Liquide, we extrapolated all environmental data to 100% in all years.
- As the acquisition of Messer was not accounted for in the environmental data of the financial year 2004, we excluded the financial performance of Messer from this assessment. Unfortunately, we could not gather information on the research expenses of Messer. Research expenses of Messer are therefore included in the number for the year 2004. Comparing research expenses of previous and later years, it can, however, be assumed that Messer's research expenses were not significant. It was also not possible to gather information on the personnel expenses of Messer in 2004. We therefore calculated the personal expenses of Messer, assuming that the salary level of Messer in 2004 corresponded to the level of salaries in Air Liquide, and excluded those personal expenses from the total personal expenses in 2004.
- Air Liquide only reports indirect CO_2-emissions and not indirect GHG-emissions. The analysis thus does not cover Air Liquide's indirect GHG-emissions other than CO_2. As there was no information on indirect CO_2-emissions for the years 2004 and 2005, we calculated the indirect CO_2-emissions from energy use, using the company's CO_2/MWh ratio of the year 2006. This calculation is based on the assumption that the energy mix of the company did not change significantly from 2004 to 2005.
- As there was no information on VOC-emissions for the years 2004 to 2006, we assumed that emissions during those years corresponded to the emissions in 2007. This assumption is based on the fact that the only 52 VOC-emitting acetylene production units already existed in the years 2004 to 2006.
- It was assumed that the reported oxidizable matter corresponds to COD.
- According to Air Liquide, the company does not dispose any significant amounts of hazardous waste. We included 1t of waste "pro memoriam" in our assessment.

Notes on data of AKZO

- According to AKZO, the scope of AKZO's environmental and social data mirrors the scope of financial reporting.
- As there was no information on direct NO_x-emissions for the years 2004 to 2006, we assumed the level of direct NO_x-emissions in 2007 for those years. This assumption was based on the fact that the NO_X-emitting combined heat and power plants existed already in the years 2004 to 2006.
- According to AKZO, emissions of other GHGs than CO_2 constitute about 2% on top of the total CO_2-emissions reported. Total GHG-emissions were calculated from total CO_2-emissions accordingly.

- We could not find any information on water use for the year 2004. The water use for the year 2004 had to be estimated using the average ratio of Net Value Added per cubic meter of water use (excluding cooling water) of the following years.
- The definition of waste for disposal at AKZO changed in 2005. We calculated the total waste for disposal for the year 2004 according to the new definition, assuming that difference between the waste send to landfill and waste send to landfill and incineration in 2005 (39,000 tons) is a fair approximation for the waste for incineration in 2004.

Notes on data of BASF

- According to the company, the consolidation of environmental and social data at BASF follows the scope of financial consolidation.
- In 2006, the scope of the environmental and social data was extrapolated from 93% to 100% to account for the acquisition of Engelhard.
- All environmental and social data include Wintershall.
- We could not gather information on the absolute number of accidents with more than one day sick leave. Consequently, that indicator was calculated from the accident rate with more than 1 day sick leave per 1 million work hours assuming 1,750 work hours per employee per year (in line with the average OECD working hours (OECD, 2007)).

Notes on data of Bayer

- According to the company, the consolidation of environmental and social data at Bayer follows the scope of financial consolidation.
- There was no information on the GHG-emissions of Lanxess in 2004. To calculate Bayer's total GHG-emissions for the year 2004, it was therefore assumed that Lanxess' contribution to total GHG-emissions was the same as to CO_2-emissions in 2004 (= 17%).
- There was no information on the amount of cooling water used by Lanxess in 2004. It was assumed that the ratio of total water use to cooling water (2 to 1) of Bayer corresponded to the ratio at Lanxess.
- Bayer no longer reports on COD. COD was calculated from TOC (Total organic Carbon) using the company's formula (COD = TOC*3).
- It was not possible to gather information on waste on a dry basis. According to the company no reasonable approximation is possible. The waste of Bayer thus contains unknown but significant levels of water.
- We could not gather information on the absolute number of accidents with more than one day sick leave. Consequently, the indicator was calculated from the accident rate with more than 1 day sick leave per 1 million work hours assuming 1,750 work hours per employee per year (in line with the average OECD working hours (OECD, 2007)).

Notes on data of DOW

- According to DOW, the company's environmental and part of its social data have been consolidated backwards to correspond to the structure of the company in 2007. Unfortunately, there are no financially backwards consolidated data available to match the scope of environmental data. We have decided against re-calculating any environmental or financial data, due to the fact that changes in company structure in 2007 were not significant. We acknowledge the fact there is a slight mismatch of scopes of consolidation.
- DOW includes the effect of joint ventures in their operative cash flows. These cash flows have been excluded from the financial return figures to ensure comparability of this assessment with other companies.
- Waste at DOW is not tracked on a dry basis. The non-hazardous waste for disposal consequently thus contains unknown but significant levels of water.
- DOW does not track hazardous waste that is in line with definitions of the other companies in this study. The indicator has consequently been excluded from this assessment and performance was set to the average performance of the companies included in this assessment.

Notes on data of DSM

- According to DSM, the scope of environmental and social data mirrors the scope of financial reporting.
- Environmental data for the year 2004 did not include newly acquired DNP and DNCC businesses. After consulting with DSM, we calculated the environmental data using the estimations given for DNP and DNCC in the DSM sustainability report 2004, page 37.
- We could not find information on waste figures for the year 2004 (hazardous and non-hazardous). Waste figures for 2004 therefore had to be estimated using the average ratio of Net Value Added per ton of waste of the following years.
- We could not gather information on the absolute number of accidents with more than one day sick leave. Consequently, that indicator was calculated from the lost-workday cases per 100 employees and recordable injuries rate of each year reported by the company.
- Water use excluding water used for cooling purposes was calculated according to DSM's estimation that 40% of all water use is used for cooling purposes.

Notes on data of DuPont

- According to DuPont, the scope of environmental and social data mirrors the scope of financial reporting.
- We could not gather information on the use of cooling water. Water use excluding cooling water had to be calculated using the BASF ratio, which stipulates that 67% of the water used is used for cooling purposes.

- No information on non-hazardous waste and COD could be gathered. The indicators could not be included in assessment of DuPont and performance was set to the average performance of the other companies included in this assessment (see chapter 3.5.2).
- We could not gather information on personal expenses. Personal expenses at DuPont were estimated using the personal expenses per person at DOW of the respective year.
- We could not gather information on the energy used by DOW in 2007. Energy use for the year 2007 therefore had to be estimated based on the available data of GHG-emissions assuming that the average ratio of GHG/MWh in 2004 to 2006 corresponds to the ratio in 2007.

Notes on data of Reliance

- The "Oil-exploration business" of Reliance is not included in its environmental data. We thus had to exclude the business unit “oil and gas separation” (in years 2006 and 2007) and “other businesses” (in years 2004 and 2005) from the financial data to create a matching scope of consolidation for environmental and financial data. The indicators number of employees, research expenses and personal expenses include the entire Reliance group, as no information is available for these indicators on business unit level. A return figure for the entire Reliance group has been used to calculate the efficiency of these indicators on the company and benchmark level. Consequently, there are two different yet internally consistent scopes within the assessment of Reliance in this survey.
- We could not find information on the use of cooling water. Water use excluding cooling water was calculated according to Reliance’s estimate the total amount of water used excluding water used for cooling purposes is approximately 25 to 30 percent of total water consumption. We assumed 30 percent.
- There was no information on total energy use for the year 2006. To calculate the energy use for the year 2006, we approximated energy use based on the available data on GHG-emissions assuming that the average ratio of GHG to MWH in 2004 and 2005 corresponded to the ratio of GHG to MWh in 2006. This calculation is based on the assumption that the energy mix of the company did not change significantly from 2004 and 2005 to 2006.
- There was no information on VOC-emission for the year 2006. We therefore assumed an identical increase of VOC-emissions from 2005 to 2006 as could be found for the other air emissions reported (+30%). We did not use the net value added for an extrapolation of the VOC-emissions due to the vast changes in company structure of Reliance during that year.
- Reliance tracks waste generation, and no information or estimation on waste for disposal could be gathered. Consequently, the indicator is not 100% in line with the indicators of other companies in this assessment.

- No environmental data for the financial year 2007 had been published by Reliance on completion of this survey. We have estimated the environmental data for the year 2007 based on the ratio of sales per resources of the year 2006. This estimation has only been used for constructing the benchmark and not for a company-level assessment of Reliance (see chapter 3.5.2).

Notes on data of Shell Chemicals

- According to Shell Chemicals, the scope of environmental and social data mirrors the scope of financial reporting.
- Shell Chemicals does not publish information on other greenhouse gases than CO_2-emissions. We therefore had to estimate total GHG-emissions according to the ratio of CO_2-emissions to GHG-emissions at Shell Group.
- We could not gather information on the absolute number of accidents with more than one day sick leave. Consequently, that indicator was calculated from the reported accident rate with more than 1 day sick leave per 1 million work hours assuming 1,750 work hours per employee per year (in line with the average OECD working hours (OECD, 2007)).
- We could not gather information on the use of cooling water. Water use excluding cooling purposes thus had to be calculated using a BASF ratio which stipulates that 67% of water used is used for cooling purposes.
- Shell Chemicals tracks waste generation. No information or estimation on waste for disposal could be gathered. We acknowledge that the indicator is not 100% in line with the indicators of other companies in this assessment.
- We could not gather information on Shell Chemicals' personnel expenses. They have been estimated assuming that the level of personal expenses per person in Shell Chemicals corresponds to the level of personal expenses per person at Shell Group.
- We could not gather any information on Shell Chemicals' total energy use or research expenses. These indicators have consequently been excluded from this assessment of Shell Chemicals and were set to the average performance of the companies included in this assessment (see chapter 3.5.2).
- No environmental data for the financial year 2007 had been published by Shell Chemicals on completion of this survey. We have estimated the environmental data for the year 2007 based on the ratio of sales per resources of the year 2006. This estimation has only been used for constructing the benchmark and not for a company-level assessment of Shell Chemicals (see chapter 3.5.2).