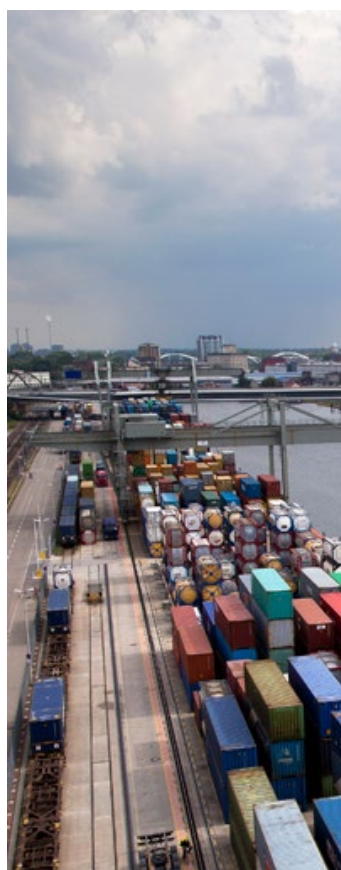


# Value-to-Society

Measurement and monetary valuation of BASF's impacts in society

 **BASF**  
We create chemistry



## Motivation

Based on our company purpose “*We create chemistry for a sustainable future*”, we strive to improve our positive contribution to society and minimize our negative effects. “BASF’s Value-to-Society” is a cornerstone of our efforts to identify, quantify, value, and demonstrate our economic, social, and environmental impacts.

With the Value-to-Society approach, we are entering a new area of performance measurement that goes beyond established qualitative and quantitative assessments. For the first time, we measure and value the financial and non-financial external effects of our business activities in society in a common unit – the euro. The results reflect our ‘real’ value contribution to human well-being through our benefits and costs to society; e.g. the societal costs of carbon emissions. Through BASF’s Value-to-Society we assess our relevant impacts along our entire supply chain, our own operations, and our customer industries. It was tested at the corporate level, for business units, for projects and strategic decisions, and at product level. We designed Value-to-Society to be a pragmatic, scalable, transferable and auditable model.

Our holistic approach provides the following benefits:

- Perspective change: Offering a macro-societal view on the performance of the company
- Transparency: Mapping our own impacts and our partners along the value chain
- Materiality: Comparing financial and non-financial impacts in a monetary business language
- Interdependencies: Better understanding of the correlations between the different capitals
- Tangibility: Demonstrating non-financial impacts in monetary terms to improve communication

We want to share our experience and learnings with our external partners and stakeholders to contribute to the continued standardization and operationalization of impact valuation. We recognize that impact valuation is still an evolving field. However, we feel that we have reached a level of maturity at which the outputs from such analyses provide valuable insights to inform communications, reporting, progress monitoring, materiality analyses, risk management, and business decision-making.

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## Table of Contents

<b>1. Introduction.....</b>	<b>p.3</b>
<b>2. Principles.....</b>	<b>p.3</b>
<b>3. Scope.....</b>	<b>p.4</b>
<b>3.1 Value chain coverage.....</b>	<b>p.4</b>
<b>3.2 Impact categories.....</b>	<b>p.5</b>
<b>4. BASF’s Value-to-Society – Results at corporate level.....</b>	<b>p.6</b>
<b>5. Overview of data and methodologies (corporate level).....</b>	<b>p.6</b>
<b>5.1 BASF’s own operations.....</b>	<b>p.7</b>
<b>5.2 Supplier and customer pathways.....</b>	<b>p.7</b>
<b>5.3 Valuation techniques.....</b>	<b>p.9</b>
<b>5.4 Mitigating distortive effects.....</b>	<b>p.12</b>
<b>6. Summary and application fields.....</b>	<b>p.13</b>
<b>Disclaimer.....</b>	<b>p.14</b>
<b>Feedback by our stakeholders.....</b>	<b>p.15</b>
<b>Annex 1 – Impact pathways.....</b>	<b>p.16</b>
<b>Annex 2 – Key methodological considerations.....</b>	<b>p.25</b>
<b>Annex 3 – Social impact valuation.....</b>	<b>p.26</b>
<b>Annex 4 – Valuation coefficients (excerpt).....</b>	<b>p.28</b>
<b>Annex 5 – Assurance Report of the Independent Auditor.....</b>	<b>p.29</b>

## 1. Introduction

This paper is intended for impact valuation program managers, sustainability leaders and stakeholder with interest in impact measurement and valuation. We aim to provide a strategic summary of our Value-to-Society approach and the benefits that it has brought to our business, as well as some of the key challenges that we have faced along the way. We hope this will stimulate, support and guide others to further elaborate the benefits of impact valuation for their business.

BASF's Value-to-Society was developed together with PwC Germany and PwC U.K. (PwC). It builds on key aspects of PwC's Total Impact Management and Measurement (TIMM) approach. This paper aims to summarize all important technical information of our Value-to-Society approach in a clear and concise manner. Areas where the TIMM methodologies have been substantially developed further and successfully piloted are explained in more detail, such as the assessment of customer industries (chapter 5.2) and the mitigation of distortive effects (chapter 5.4). However, it is not intended as a detailed technical discussion of our approach, and readers with a technical or academic background may wish to contact us for more information. Rather, we aim to provide a summary of our approach for others to reflect on and to stimulate further advancements in this field in the future.

## 2. Principles

The Value-to-Society approach is oriented towards the following quality criteria, based on the GRI Sustainability Reporting Standards<sup>1</sup> and the Natural Capital Protocol<sup>2</sup>.

- **Accuracy:** The Value-to-Society results are sufficiently accurate and detailed for stakeholders to assess BASF's performance related to economic, social, and environmental impacts (chapter 4).
- **Completeness:** Within the set boundaries (chapter 2) the Value-to-Society approach covers significant material economic, social, and environmental impacts caused and enabled by BASF's business activities. It enables stakeholders to assess BASF's performance in the reporting period. The specific impacts are outlined in the so-called impact pathways (Annex 1).
- **Comparability / consistency:** Value-to-Society selects, compiles, and communicates information consistently. The information is presented in a manner that enables stakeholders to analyze changes in the BASF's performance over time ([basf.com/en/value-to-society](https://www.basf.com/en/value-to-society)) as well as between economic, social and environmental areas. Value-to-Society applies accepted methods as available consistently across the defined boundaries (chapter 5).
- **Balance:** The Value-to-Society approach reflects both positive and negative impacts on society to enable a reasoned assessment of overall performance (chapter 4).

<sup>1</sup> Global Reporting Initiative (2018): CONSOLIDATED SET OF GRI SUSTAINABILITY REPORTING STANDARDS 2018, p.7-16

<sup>2</sup> Natural Capital Coalition (2016): Natural Capital Protocol, p.6

- **Timeliness:** The Value-to-Society is calculated and communicated on an annual schedule. Methodologies, boundaries and processes of assessment are reviewed on an annual basis and adjusted if required (chapter 4).
- **Clarity:** The Value-to-Society process and results are presented in a manner that is understandable and accessible for relevant stakeholders (chapter 4).
- **Reliability / replicability:** The Value-to-Society approach gathers, records, compiles, analyzes, and communicates information and processes used in the calculation in a way that can be subject to examination, and that establishes its quality and materiality (chapter 5, annex 1-4).
- **Rigor:** The Value-to-Society approach uses technically robust (from a scientific and economic perspective) information, data, and methods that are fit for purpose and publicly available wherever possible (chapter 5, annex 1-4).

### 3. Scope

As a chemical company we operate in different value chains with purchases from and sales into nearly every industry and country. BASF's Value-to-Society approach strives to value the impact of our business activities in society as holistically and pragmatically as possible. It was tested at the corporate level, for business units, for projects and strategic decisions, and at product level.

#### 3.1 Value chain coverage

The boundaries for the calculation along the value chain are defined based on the relevance of the value chain step, the availability of data and methodologies, and the feasibility of the calculation approach at each level of our business. These are:

- **Corporate level:** This includes BASF's own operations, direct and indirect suppliers (tier 1 to tier n), and customer industries. All are aligned within the boundaries of our financial reporting.
- **Project level:** This is dependent on a project's characteristics – for example, site development activities are covered during both construction of the site as well as during production.
- **Business unit and product level:** This encompasses BASF own operations, direct and indirect suppliers (tier 1 to tier n), customer industries, product use phase and end-of-life.

The use phase and end-of-life impacts associated with products made by our customers are extremely diverse. Various approaches are available to measure and value these impacts. However, a comprehensive coverage of the impacts of our entire portfolio in the use and end-of-life phase requires a detailed mapping of more than 60,000 product applications. As data and valuation methods for certain impacts are not yet available for our entire portfolio, the use and end-of-life phase were tested on a case-by-case basis at product level. Currently, an implementation at corporate level is not feasible.

### 3.2 Impact categories

The impact categories currently included in BASF’s Value-to-Society approach are selected based on a combination of materiality for our business, availability of reliable data, and suitable methods as well as practicability and feasibility of calculation. A core set of impact categories is applied in all assessments for the production process of a product including: Entire supply chain, our own operations, and production processes in customer industries.

The baseline model includes the following impact categories:

- Economic (EBIDA): Profits (including interests), amortization and depreciation
- Social: Taxes, wages and benefits, human capital (for own operations only), health and safety
- Environmental: Air pollution, greenhouse gases (GHGs), land use, water use, water pollution, and solid waste.

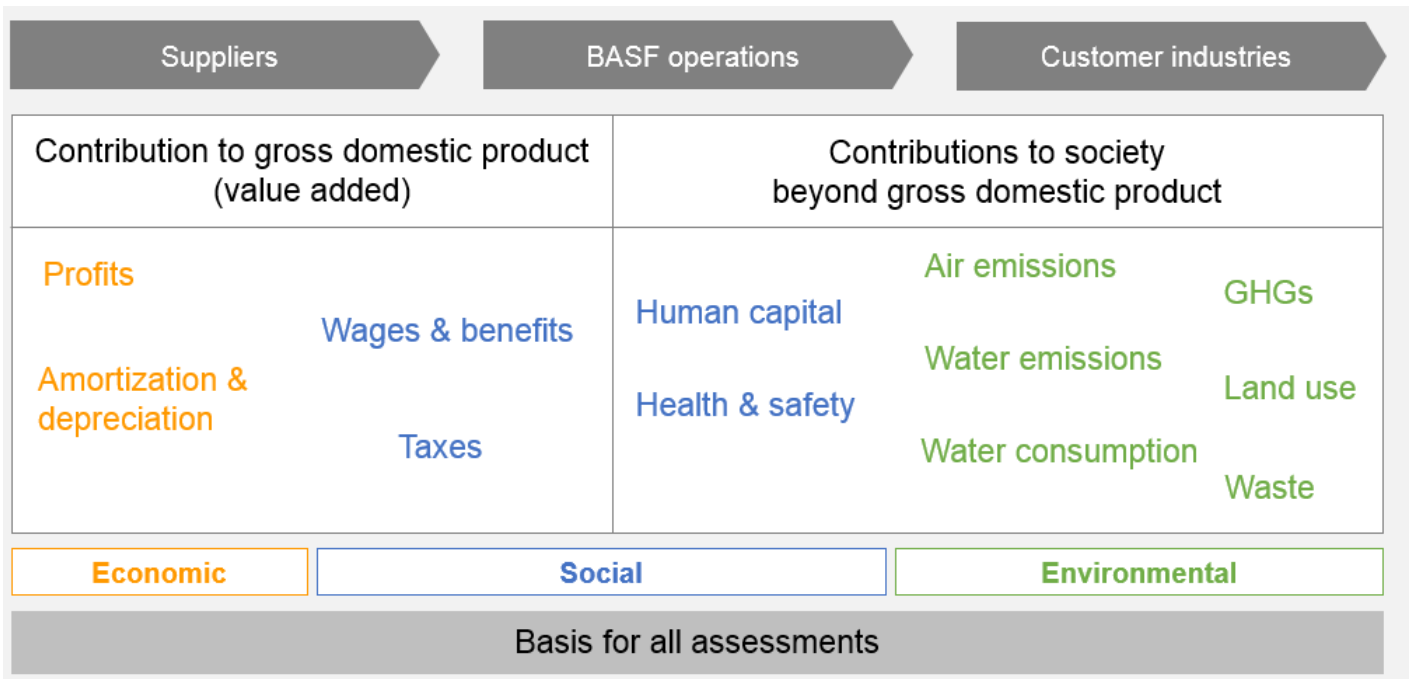


Diagram 1: Scope of BASF’s Value-to-Society approach at corporate level.

Where relevant, additional impact categories can be included on a case-by-case basis. For example, in a pilot of a new production site a number of related impacts on communities were considered. For the product use phase and end-of-life, specific impact categories can be applied according to the materiality for the final product, e.g., human health.

However, some material impacts, such as human and labor rights, are not yet included in BASF’s Value-to-Society due to maturity concerns around data availability and the absence of widely accepted quantification and valuation methods.

## 4. BASF's Value-to-Society – Results at corporate level

BASF's Value-to-Society results are available dating back to 2013. The calculations demonstrate the absolute value and contribution to society in monetary terms, rather than the difference between our contribution and a baseline such as the average impact of the chemical industry.

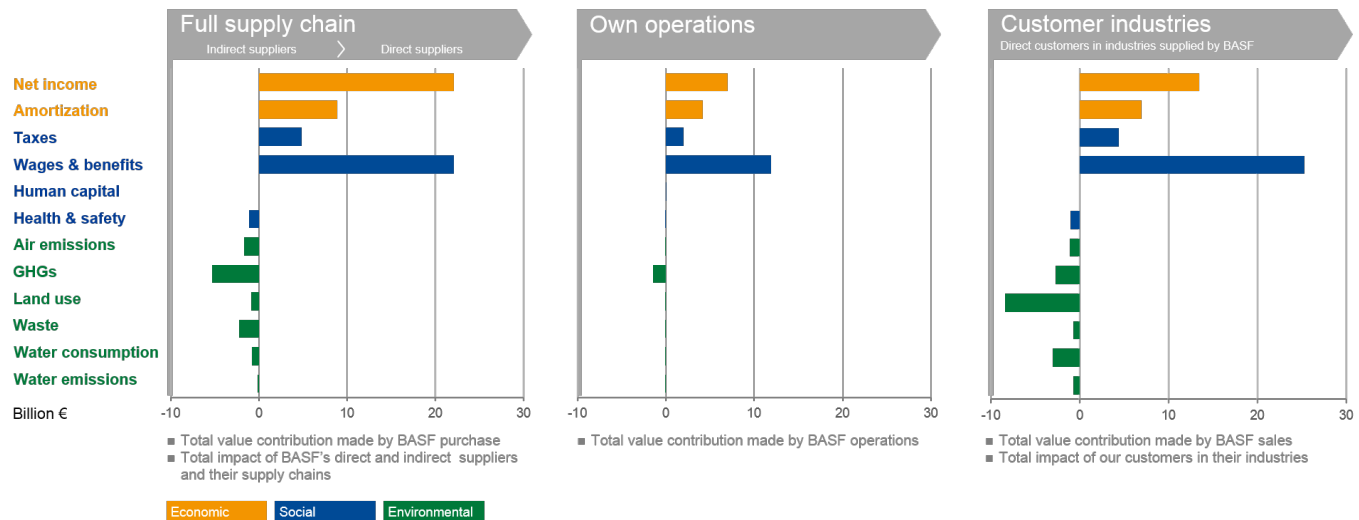


Diagram 2: Results of BASF's Value-to-Society assessment BASF Group 2017.

According to our analysis, BASF's value contribution to society has been net positive from 2013 to 2017, and the results show a stable distribution of economic, social, and environmental impacts. In each step of the value chain, the benefits of our business activities substantially exceed the costs to society. Economic impacts are positive along with taxes, wages and benefits, and human capital. Negative impacts are health and safety incidents as well as impacts on the environment.

Significant deviations in our results occur due to growth rates or portfolio changes, e.g. the divestment of our gas trading business in 2015. Our latest results, including the observed changes over time, are presented at [basf.com/en/value-to-society](http://basf.com/en/value-to-society).

## 5. Overview of data and methodologies (corporate level)

BASF's Value-to-Society assumes that impacts on society are generated by our own operations and enabled along the supply chain and customer industries through our procurement and sales activities. A precondition for the impact measurement and monetary valuation of business activities in society is the availability of data linking business activities to quantities of impacts (e.g. wages paid or GHGs emitted). As primary data is not fully available along value chains, BASF's Value-to-Society approach uses the following data:

- Primary BASF data for the output of our own operations and for the purchase and sales

profile of our business (including value, location, and industry of purchase/sales)

- Secondary data (e.g. industry averages) for enabled output of direct and indirect suppliers and customer industries that are enabled by our purchase and sales activities.

These data sets enable a pragmatic quantification of impacts based on the methods of aggregation for our own operations as well as multi-regional input-output modelling for the entire supply chain and customer industries. The application of secondary industry data and input-output modelling leads to indicative results for suppliers and customer industries since these reflect only the average impacts of a certain industry and not the specific impacts of our business partners.

	Suppliers	BASF operations	Customer industries
Data source	Purchase profile: Primary data (BASF Global procurement database)	Output: Primary data (Financial accounting, Environmental health & safety database, Human resources databases, dedicated surveys)	Sales profile: Primary data (BASF Sales by industry survey)
	Output: Secondary industry data (e.g., Global Trade Analysis Project, World Bank, ILO, OECD, EU)		Output: Secondary industry data (e.g., Global Trade Analysis Project, World Bank, ILO, OECD, EU)
Impact quantification	Supplier pathway	Aggregation of operational data	Customer pathway

Diagram 3: General overview about data and quantification methods used.

### 5.1 BASF's own operations

Primary data is used to quantify the impacts of our own operations on society. Depending on the data source, the respective data at a legal entity, site level or country level are aggregated at the corporate level. Almost all data is collected from sources that are audited for BASF's Annual Report. A small share of supplementary data is collected via targeted surveys.

### 5.2 Supplier and customer pathways

#### Direct and indirect suppliers

Our procurement activities enable impacts to society through the activities of direct and indirect suppliers. To assess these impacts, our share in direct supplier industries (tier 1) is allocated based on the procurement value. The consequential impacts to society by indirect suppliers (tier 2 to tier n) are calculated via input-output modelling, an established technique that is used to estimate the activity in different economic sectors triggered by spending in specific sectors.



The estimated economic, social, and environmental impacts of BASF’s entire supply chain are quantified using publicly available secondary data and multiplied with respective, country-specific monetary valuation coefficients provided by PwC.

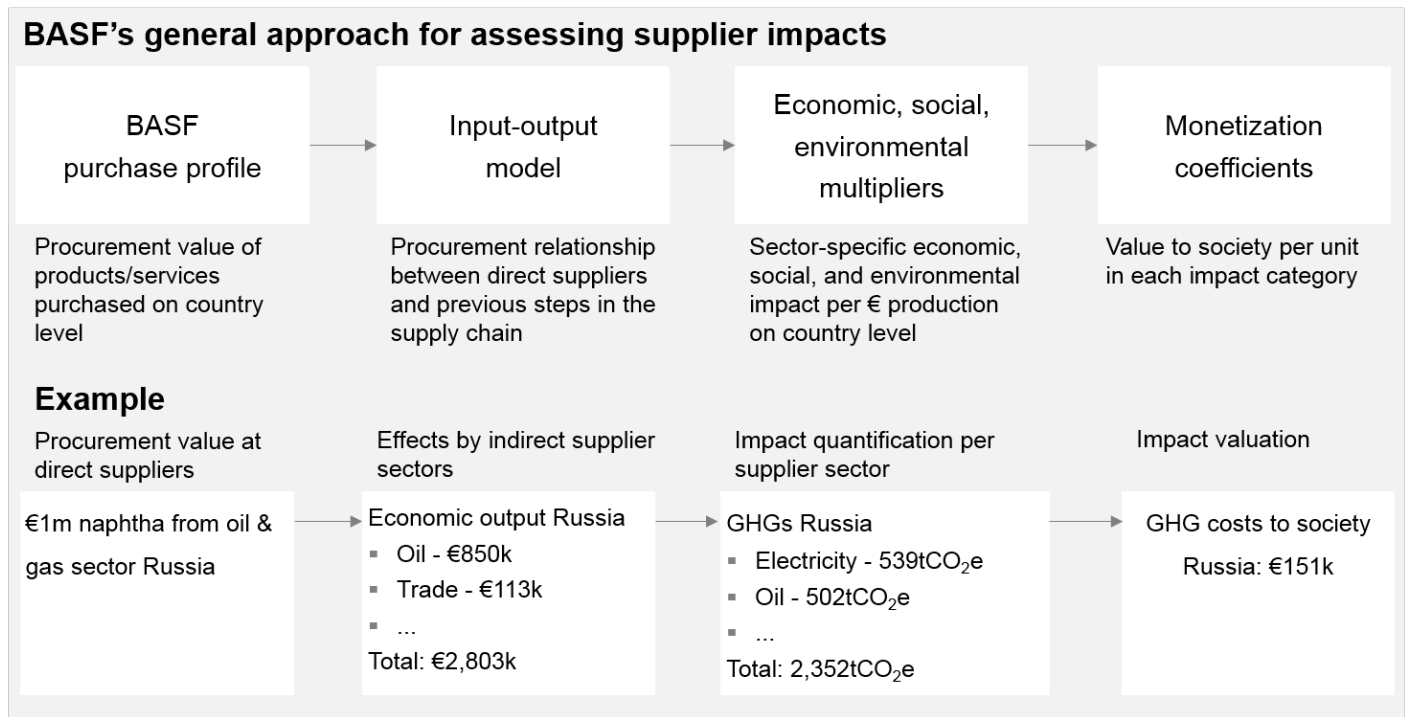


Diagram 4: Calculation of supplier pathway.

### Customer industries

Our customer industries have significant economic, social, and environmental impacts on society which are partly enabled by our sales activities. As we are not the sole supplier of customer industries, we quantify the impacts of customer industries’ activities (enabled by our product applications) based on our supply share into a specific customer industry and country.

Once quantified, our impacts are valued in monetary terms equally through multiplication with respective, country-specific monetary valuation coefficients provided by PwC.

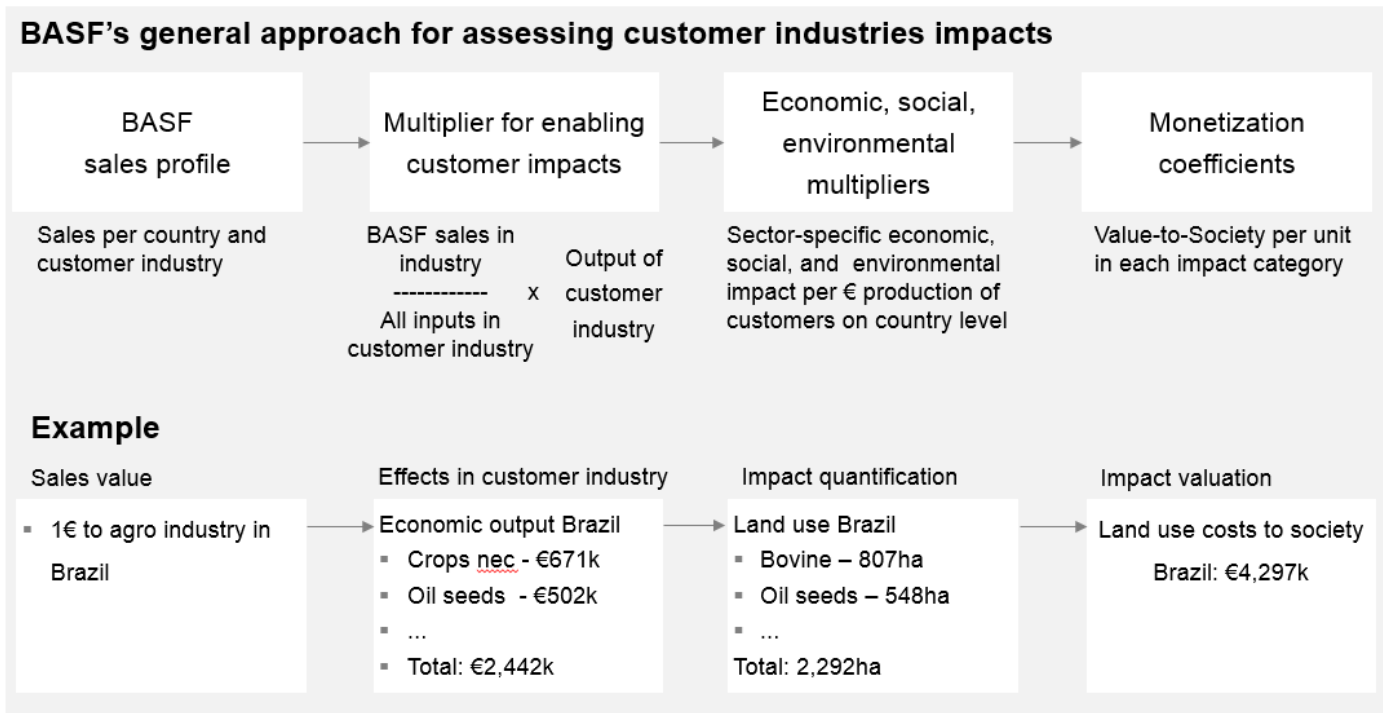


Diagram 5: Calculation of customer pathway.

### 5.3 Monetary valuation techniques

BASF's Value-to-Society approach quantifies the impacts of our business activities and values the associated external effects on society. By taking a macro-societal perspective, this approach improves upon traditional reporting in three aspects:

- **Impact of business on society:** BASF's Value-to-Society assesses the impact of our business in terms of the benefits and costs it generates for people. It evaluates how business activities affect and change human life and well-being. For example, traditional reporting takes only emitted GHGs into account, whereas BASF's Value-to-Society considers the related costs to society caused by GHG emissions (e.g. loss of economic productivity by climate change).
- **Reframing business' interactions:** Taking a more holistic view of the impact business has on society is changing the way in which flows of cost or benefit are understood. For example, traditional reporting considers taxes and wages as costs for the company, whereas BASF's Value-to-Society values these as benefits to society.
- **Comparability and understanding:** In BASF's Value-to-Society, all company-driven impacts on society are measured in a common unit: the euro. This allows, for the first time, the materiality of these impacts to be compared across financial and non-financial impact categories, as well as providing a better understanding of their interdependencies along the value chain.

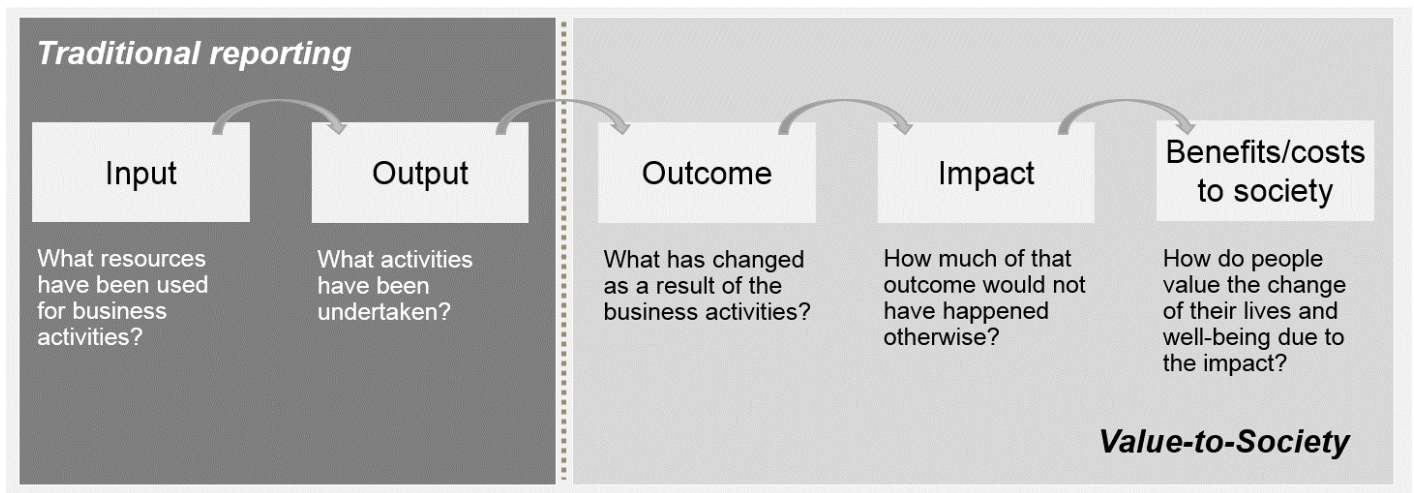


Diagram 6: The new aspects of BASF's Value-to-Society compared to traditional reporting.

### 5.3.1 Concepts of price and value

Various approaches have been taken in other studies to ascribe monetary values to business impacts. Three broad groups of approach are common, each with differing utility and implications:

- **Market price:** The amount of money for which a good or service is exchanged in a given market; e.g. the price of a Certified Emission Reduction in the EU Emission Trading System (ETS).
- **Abatement cost (or benefit):** The financial cost (or return) of implementing measures to reduce an additional unit of a specific pollutant; e.g. the cost to reduce emissions by 1tCO<sub>2</sub>e in the Automotive Sector in Germany (as reflected in a Marginal Abatement Cost Curve for that sector).
- **Value to society:** The benefits and costs to society resulting from a business activity. These benefits and costs may already be captured in market prices (e.g. wages reflect the market price of labor) or they may be currently unpriced 'externalities' of business activities (e.g., the consequences of climate change, reflected in an estimate of the social cost of carbon).

The purpose of BASF's Value-to-Society approach is to assess our 'real' contribution to a sustainable future as comprehensively as possible. An approach based on benefits and costs to society is therefore most appropriate, since existing market prices or abatement costs frequently do not fully reflect the 'real' benefits and costs to society of business activities.

### 5.3.2 Financial capital flows

The impacts associated with some activities, such as the payment of taxes or wages, is already measured in euros. But the change in welfare that the same euro can obtain in any given country differs from one country to another; e.g., the price for a defined basket of goods in Switzerland is higher than the same basket of goods in Ethiopia. So, all other things being equal, the same euro in one country will buy a different quantity of goods in one country versus another and, it is assumed, a different level of welfare.

To estimate the welfare change associated with these financial capital flows in different countries, the quantified profits, taxes, and wages and benefits are adjusted using World Bank purchase power parity (PPP) conversion factors. We believe this reflects the most representative equivalent to the 'real' long-term value to society of financial flows in a given country. In order to avoid short-term fluctuation related to more volatile exchange rates, welfare adjustments were frozen to 2011, the base year of input-output model data.

### 5.3.3 Non-financial capital flows

The impacts associated with other activities, such as the emission of GHGs or air pollution, are not already measured in financial terms. This is because the benefits and costs associated with these impacts are not 'bought' or 'sold' explicitly on the market, and so there is no market value associated with them. However, it is still possible to measure these impacts in terms of monetary value, using information about how they influence people's well-being.

There are various techniques that are used to estimate such 'non market' values. The valuation coefficients within BASF's Value-to-Society approach make use of values derived using various techniques, based on which one is deemed most appropriate in each case. In general, these techniques can be grouped in the following areas: Revealed preferences, stated preferences, and cost-based approaches (see also Natural Capital Protocol, 2015, p.86; Social Capital Protocol, 2017, p.51). The use of cost-based approaches is limited to cases where welfare-based alternatives are unavailable, and where costs can be expected to provide a reasonable proxy for changes in welfare.

Within BASF's Value-to-Society approach, country-specific monetary valuation coefficients are used, e.g. the valued impact of consuming water in China. The exception is the monetary valuation of GHG emissions: As climate change has globalized impacts, a common cost-to-society factor is applied to GHG emissions emitted in different countries.

The monetary valuation coefficients are derived from publicly available data sources such as publications from national governments, UN, World Bank, OECD, EU, or scientific studies.

A comprehensive overview on the derivation of monetary valuation coefficients is available at PwC's webpage <http://www.pwc.co.uk/naturalcapital>. The social impact valuation (human capital, health and safety) approaches are explained in the annex 3 of this document.

## 5.4 Mitigating distortive effects

BASF's Value-to-Society approach aims to assess the 'real' impact of business activities on society. Because of the global nature of our business, and because our approach examines changes in Value-to-Society over time, there are some factors that affect the result which are volatile and outside of our control. We believe the following 'exogenous' factors are misleading to include, and so our approach minimizes their effects:

- Volatility in product prices over time
- Volatility in exchange rates over time

The following examples illustrate why the effects of these factors, outside of our sphere of influence, were considered distortive to an estimate of the 'real' value assessment and are consequently minimized. However, the same drivers may still have a 'real' impact on operational financial results.

### *Volatility in product prices over time*

Our purchase and sales value are used in combination with input-output tables to identify impacts of suppliers and customer industries. As input-output tables are provided with a three to four year lag, they cannot reflect annual price changes. Consequently, using annual nominal purchase and sales values in combination with input-output tables leads to substantial fluctuations of key intermediate drivers in impact valuation calculations such as our purchase value and market share in customer industries. For example, an oil price drop of 50% leads to a markedly reduced purchase value even though the same volume (tons of oil) of product may be purchased. Environmental extensions to input-output modelling relying on the purchase value would therefore also yield lower environmental impacts even if the amount of pollution is constant. This illustrates a method price sensitivity which is considered distortive.

To mitigate changes in BASF's Value-to-Society due to these 'pure price effects', real changes are applied to: Product purchase profile changes that can be measured in physical quantities (tons, liters, m<sup>3</sup>, MWh). Meanwhile sales profile changes are measured by using volume and structure effects. The mitigation of price effects in service procurement is not possible as real changes cannot be identified. However, price volatility in services is substantially lower than for commodity prices.

### *Volatility in exchange rates over time*

The results of BASF's Value-to-Society are expressed in euros. However, PwC's monetary valuation coefficients to assess the value generated in society use US dollars as their base currency. This may lead to artificial effects in monetary valuation over time. For example, a figure of €62 was applied as the multiplier for 1t GHG emissions in 2013. If regular exchange rate conversion were used, this multiplier would have increased by 25% in 2015. This effect should be considered distortive as changes in the monetary valuation of greenhouse gases depend on environmental long-term considerations (such as climate change projections) and not on much more volatile foreign exchange rates. Therefore, for comparability between years, we froze the exchange rate conversion for monetization factors to the 2013 figure, the first year of impact assessment.

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To mitigate changes due to foreign exchange rate effects on the valuation coefficients, the exchange rate of the base year 2013 is applied in all calculations. However, this effort does not mitigate the effects of foreign exchange rates in BASF financial statements, which are used for the financial impacts in BASF operations (EBIDA, taxes, and wages).

## 6. Summary and application fields

BASF's Value-to-Society is a pragmatic, efficient and auditable approach to measure and value the impact of business activities on society. It provides a new, macro-societal perspective on our contribution to a sustainable future. By the measurement and monetary valuation of benefits and costs to society it allows a direct comparison of economic, social, and environmental impacts and a better understanding of their interdependencies.

We consider that assessments based on the outlined data and methods will lead to results that are directionally correct. Based on our experiences the results are sufficiently sound for purposes of:

- Communication and reporting to demonstrate the 'real' impact of business activities in society
- Monitoring our contribution to a sustainable future over time
- Complementary information in decision making processes.

We share our Value-to-Society approach and related learnings in the current development towards standardization in the field of impact valuation, such as Natural Capital Coalition, the Human & Social Capital Coalition, the Impact Valuation Roundtable, the Embankment Project or within ISO.

## Disclaimer

BASF's Value-to-Society approach was jointly developed by PwC and BASF. Its intention is to provide a basic understanding of BASF's contribution to a sustainable future. For this objective, we applied the best available data and methods based on the principles of pragmatism and feasibility. The results of the current approach are only estimates of BASF's value contribution to society.

Because of its nature, BASF's Value-to-Society approach cannot achieve the accuracy of the results of BASF's integrated annual report. Especially for any financial information about BASF, readers should refer to BASF's Annual Report or related publications.

As a consequence, BASF's Value-to-Society assessments in no way reflect or have any impact on BASF's past, present, or future financial performance. In particular, BASF's Value-to-Society results do not create any liabilities, implied costs or any rights to offset any amounts contained therein, nor does it trigger any provisions and neither does it result in any off balance sheet commitments.

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## Feedback by our stakeholders

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'BASF are to be congratulated for undertaking this important and ground-breaking assessment. It will no doubt act as a further vital catalyst for companies to evaluate their true overall impacts and net contribution to society - which is much needed for a more sustainable global economy. The approach set out in this Method Paper appears to be reasonably sound and relatively comprehensive. However, as is always the case with this topic, the devil is in the detail, in particular the assumptions, source references and coefficients used. Only part of this is available, and only if you are prepared to wade deep into voluminous supporting documentation. The summary of outcomes, societal impacts and types of value included within the assessment and Method Paper is though useful.'

James Spurgeon, Director, Sustain Value

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'Quantifying and monetarizing sustainability impacts and dependencies, as BASF illustrates in their commendable Value-to-Society approach, is also an important step towards more transparency, comparability and awareness when it comes to corporate sustainability risks. Such an enhanced perspective of these existing and emerging risks in the environmental, social and governance field can enable companies to design the right risk management solutions.'

Michael Bruch & Christopher Bonnet, Allianz Global Corporate & Specialty

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'Measuring the impact and value companies bring to society is crucial to embedding sustainability within corporate value chains. But not many companies do it. BASF with its Value-to-Society is therefore at the forefront. I believe that its Value-to-Society approach will help the company become even more sustainable as well as serve as a source of inspiration for numerous companies out there that are not yet measuring impact.'

*CB Bhattacharya, Pietro Ferrero Chair in Sustainability and Founding Director of the Center for Sustainable Business, ESMT European School of Management and Technology*

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"The holistic approach to measure the societal value is innovative and fosters a broader perception along the entire value chain."

Denis A. Ostwald, CEO, WifOR

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## Annex 1 – Impact pathways

Impact pathways are an established method to identify the outcomes, impacts and impact values associated with a given business activity. The following impact pathways are included to describe each area, from which the most material impacts are included in BASF’s Value-to-Society approach.

### Economic impacts: *Profits, amortization, depreciation (EBIDA)*

In order to quantify benefits to society provided by BASF’s corporate earnings, the EBIDA is taken into account consisting of net income before interest, depreciation and amortization. As taxes are valued in a separate impact category, this indicator ensures the reflection of the actual earnings generated by BASF. The respective benefits to society are monetized by applying The World Bank’s PPP conversion factors.

### Social impacts: *Taxes, wages and benefits*

In order to quantify the benefits to society provided by BASF due to public dues and employment, total tax payment as well as wages and benefits are taken into account. The respective benefits to society are monetized by applying The World Bank’s country-specific PPP conversion factors.

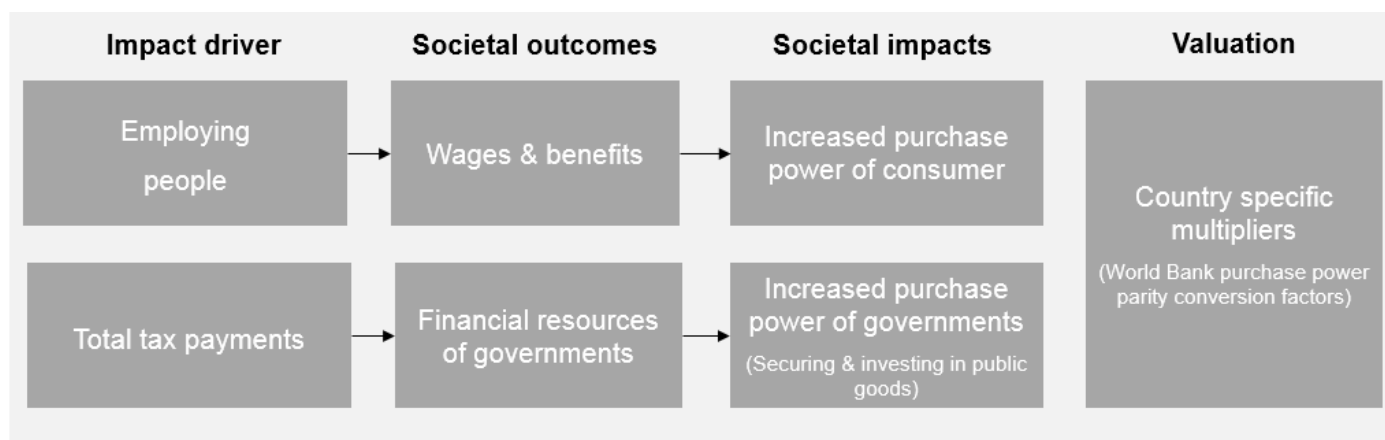


Diagram 7: Impact pathway ‘Wages & benefits’ and ‘Taxes’

### Social impacts: *Human Capital*

In order to quantify and value the benefits to society provided by human capital, corporate development programs and funding of education are taken into account. Improved experience and skills lead to higher wages – by a wage increase either at an individual’s current or future employers. The projected future additional earnings of trained employees after leaving BASF are considered to benefit society through higher purchase power of employees and higher wage taxes. These benefits are projected into the future using country-specific wage growth rates and discounted to their value today.

BASF training data and staff leaving rates are used for quantification. The other parts of BASF’s value chain are not covered due to a lack of available data.

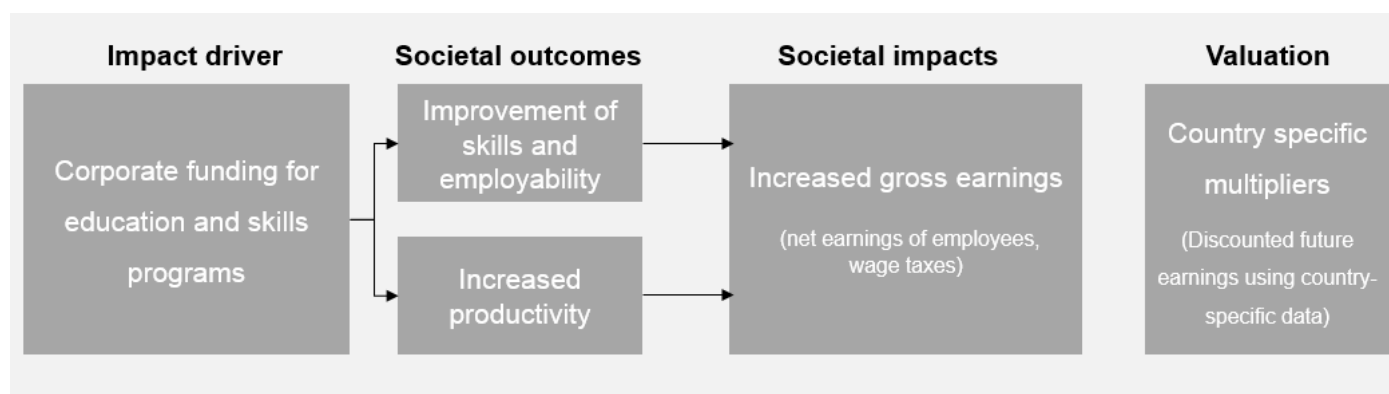


Diagram 8: Impact pathway 'Human capital'

### Social impacts: *Health and Safety*

In order to quantify and value the costs to society caused by health and safety (H&S), incidents along the value chain are taken into account. The approach covers accidents and long-term injuries, illnesses, or exposure to toxicity as they lead to impacts on the society such as health, economic disruption, use of medical resources, or reduced output to economy. Positive impacts such as health promotion programs or product safety trainings are not covered separately.

BASF quantifies the H&S outputs caused along the value chain on multiple data sources for incident intensities. They include primary as well as secondary databases; e.g. the International Labour Organization (ILO) statistics database. This approach estimates the costs to society in the form of country-specific coefficients for different severity of incidents, illnesses and fatalities, which are applied to the relevant number of incidents in each country.

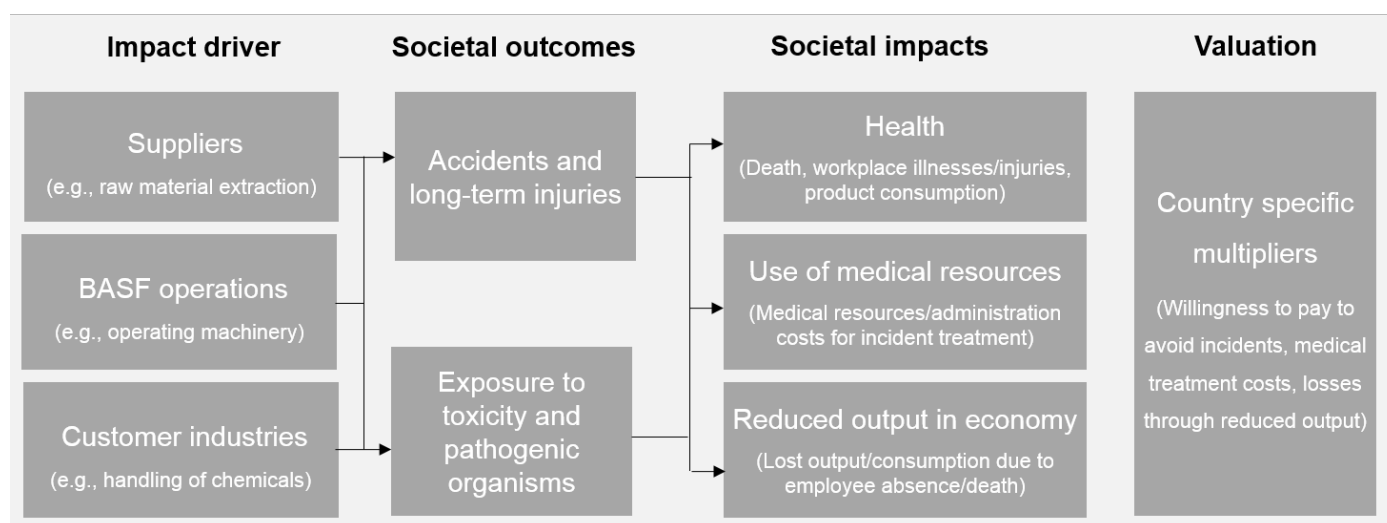


Diagram 9: Impact pathway 'Health & safety'

### Environmental impacts: Air pollution

In order to quantify and value the costs to society caused by air emissions, six main pollutants are taken into account. Emitting these pollutants reduces the quality of air either directly or indirectly by contributing to the formation of secondary pollutants. The reduced quality of air leads to impacts on society such as human health, visibility, or agricultural productivity.

BASF quantifies changes in the specified pollutant concentrations using an air dispersion model and the mass of air emissions from corporate activities along the value chain. The effect of increased concentrations on human health is modeled using dose-response functions for respiratory diseases and then valued using “willingness to pay” estimates. This results in country-specific coefficients for each pollutant that represent the cost to society. The coefficients are applied to the quantified mass of each pollutant across BASF supply chain.

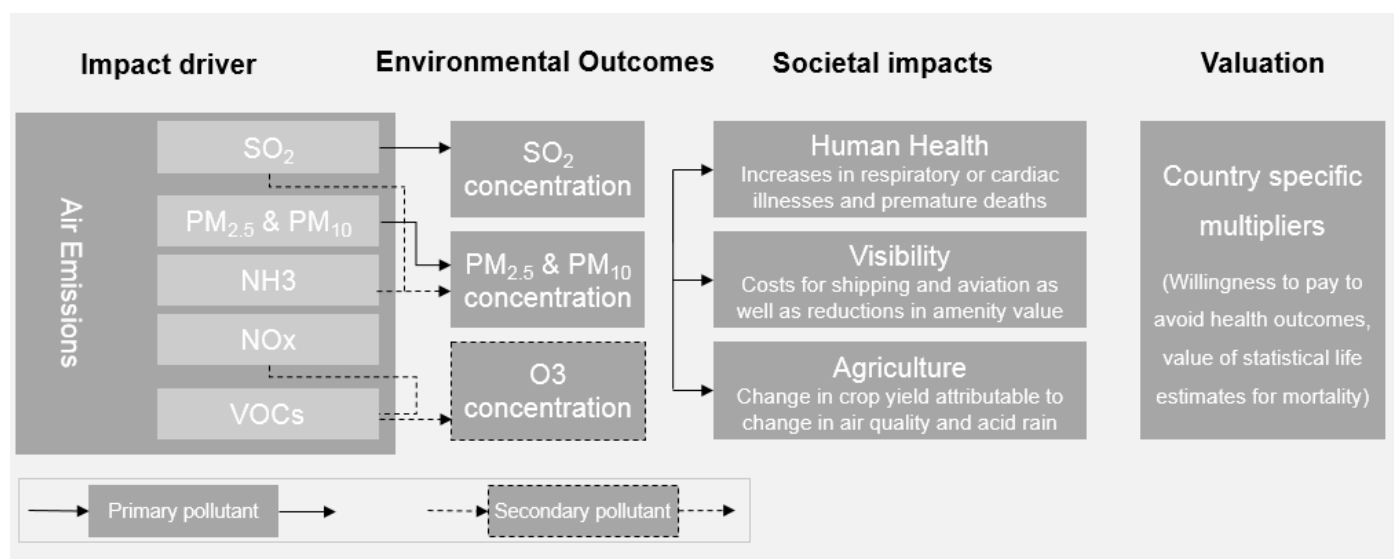


Diagram 10: Impact pathway 'Air emissions'

**Environmental impacts: Greenhouse gases**

In order to quantify and value the costs to society caused by GHGs, six main types of emissions are taken into account. These emissions lead to increasing atmospheric concentrations of the respective gases. This affects the environment in different ways including shifting climate patterns or increasing extreme weather events. These environmental outcomes lead to impacts on society including: Human health, built environment, economic disruption, agriculture and timber, and desertification.

BASF quantifies the resulting environmental outcomes using the mass of GHG emissions from corporate activities along the value chain in CO<sub>2</sub> equivalents. The respective costs to society are valued applying a global coefficient based on a meta-analysis of recent Social Cost of Carbon estimates.

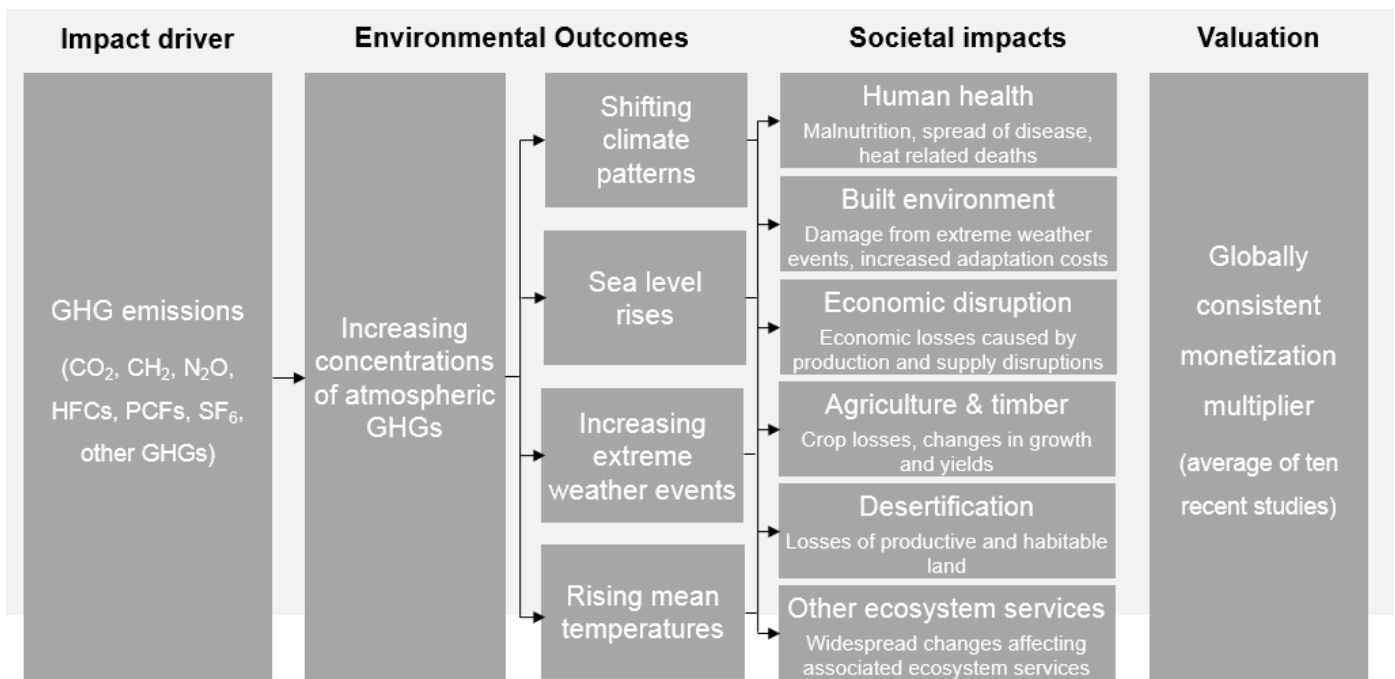


Diagram 11: Impact pathway 'GHGs'

**Environmental impacts: Waste**

In order to quantify and value the costs to society caused by solid waste disposal, non-hazardous and hazardous waste are taken into account. In addition, the method of waste disposal is considered, i.e. landfill or incineration. Waste disposal has several effects on the environment such as GHG emissions, land use, leachate release, and other emissions to air, noise, odor, or visual intrusion. These outcomes lead to climate change and impacts on society such as human health, and disamenity.

BASF quantifies environmental changes using different approaches for respective outcomes such as a risk-based approach in case of leachate or using a model by the Intergovernmental Panel on Climate Change (IPCC) to estimate the GHG emissions as landfill waste decomposes. National level data is collected to estimate country-specific coefficients that represent the cost to society. These are applied to the quantities of hazardous and non-hazardous waste across BASF’s value chain.

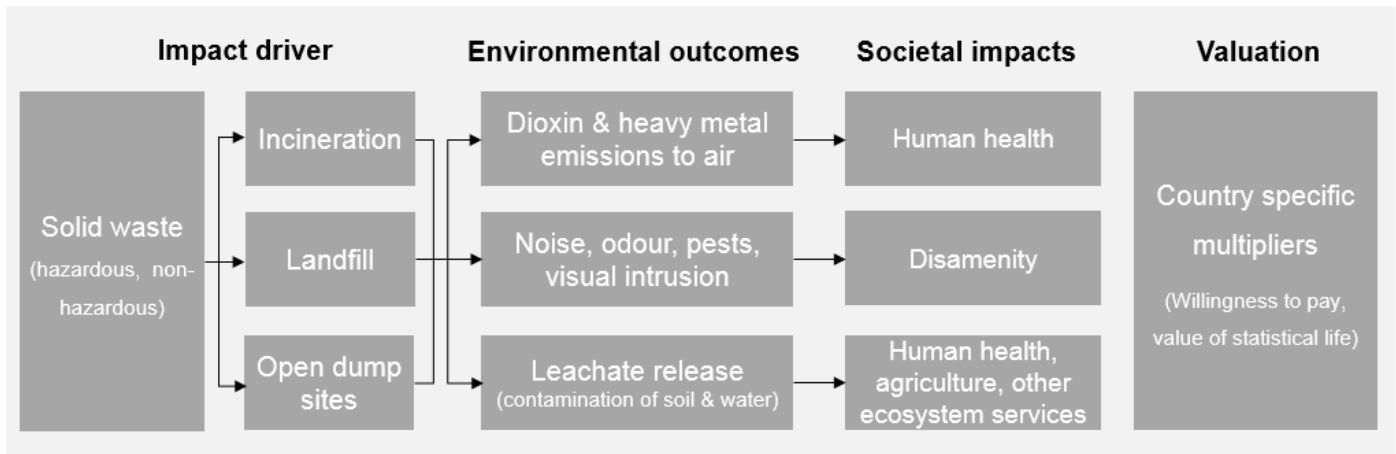


Diagram 12: Impact pathway ‘Waste’

**Environmental impacts: *Water pollution***

In order to quantify and value the costs to society caused by emissions to water, inorganic and organic pollutants as well as nutrient discharges are taken into account. The latter includes nitrogen and phosphorus. For all other discharges, sixteen main pollutants are covered such as arsenic or mercury. Emitting these pollutants reduces the water quality and affects livestock and water consumers. This leads to various impacts on people such as human health, loss in recreation, changes to property values, or reduction of fish stocks.

BASF quantifies the environmental outcomes caused by emissions to water using a model based on the chemical fate and likelihood of human exposure, which considers the different characteristics of pollutants. The costs to society of each pollutant that is emitted to water are estimated in country-specific coefficients. The coefficients are applied to the quantities of each water pollutant respectively across BASF’s value chain.

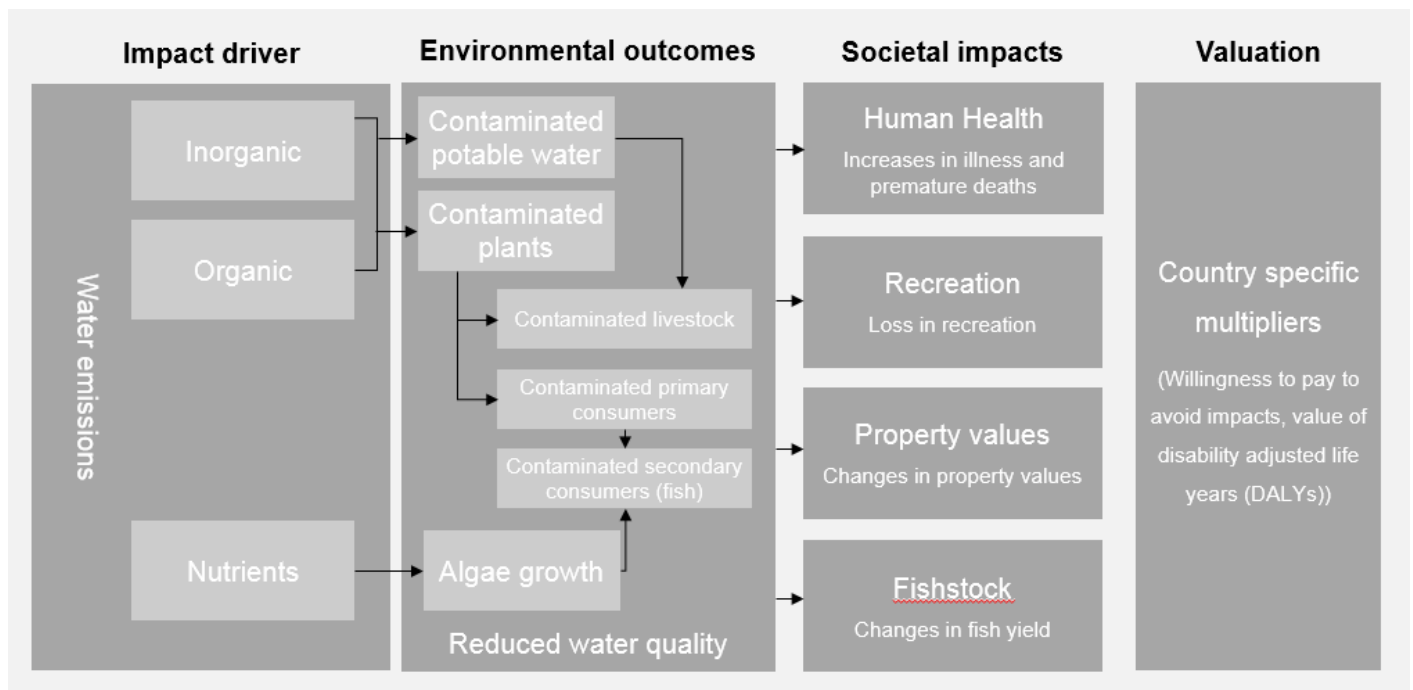


Diagram 13: Impact pathway ‘Water emissions’

**Environmental impacts: *Water consumption***

In order to quantify and value the costs to society caused by corporate water consumption, the societal impacts covered are reduced water availability and depleted stock of ground water. They can lead to malnutrition, diseases or increasing costs for water supply.

BASF quantifies the environmental outcomes caused by water consumption using the volume of corporate water consumption and the respective water stress level based on a water stress index (WSI). Moreover, the depletion rate and depletion time are taken into account. The costs to society of water consumption are valued using country-specific data to create valuation coefficients. The valuation coefficients are applied to water consumption in each country in BASF’s value chain.

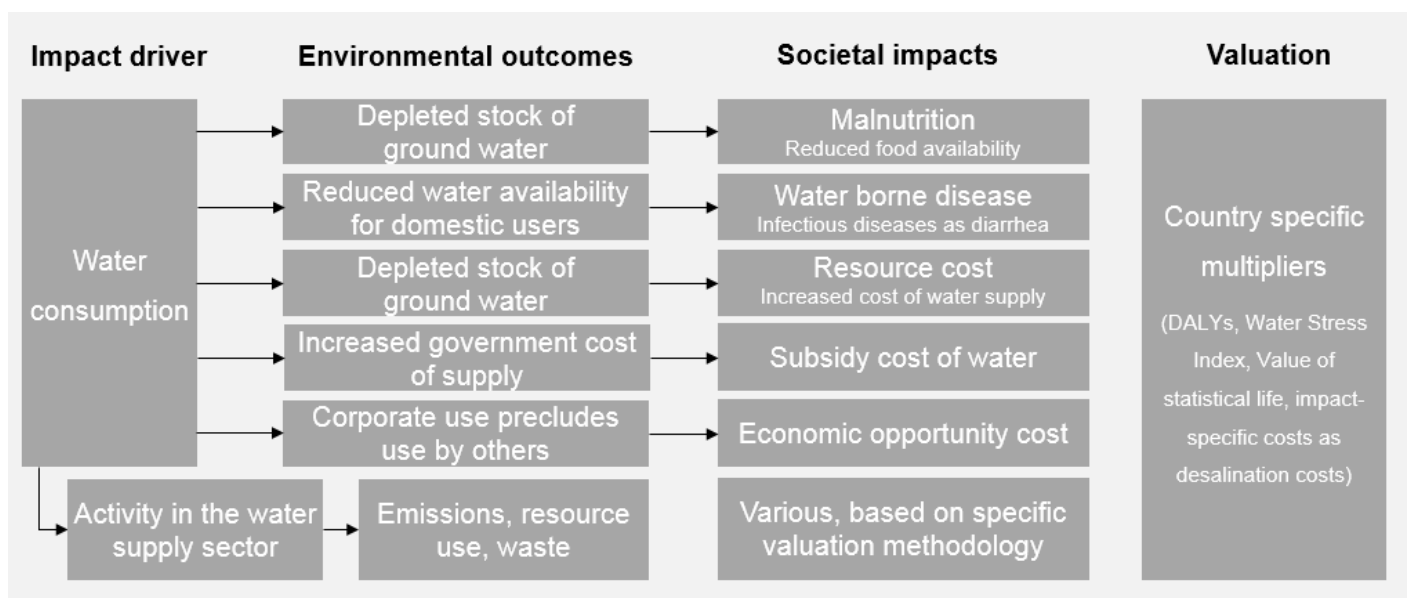


Diagram 14: Impact pathway 'Water consumption'



**Environmental impacts: Land use and biodiversity**

In order to quantify and value the costs to society caused by land use, BASF distinguishes between new conversion of natural ecosystems and occupation of already converted land. Driven by different factors such as the demand for raw materials or production sites, land use affects services provided by ecosystems. These are clustered in: Provisioning services (e.g. food supply), cultural services (e.g. recreation) and regulating services (e.g. carbon storage). Changes in these services lead to impacts on the society in areas such as economic disruptions, human health and cultural aspects.

BASF quantifies the associated changes in ecosystem services based on the country-specific land use by analyzing the comparative biomass- and species-richness of the new land use relative to the natural eco-region. The respective costs to society are derived from the loss of ecosystem services due to use and conversion of land and used to estimate country-specific valuation coefficients. The land use type and country specific coefficients are applied to the hectares of land across BASF’s value chain.

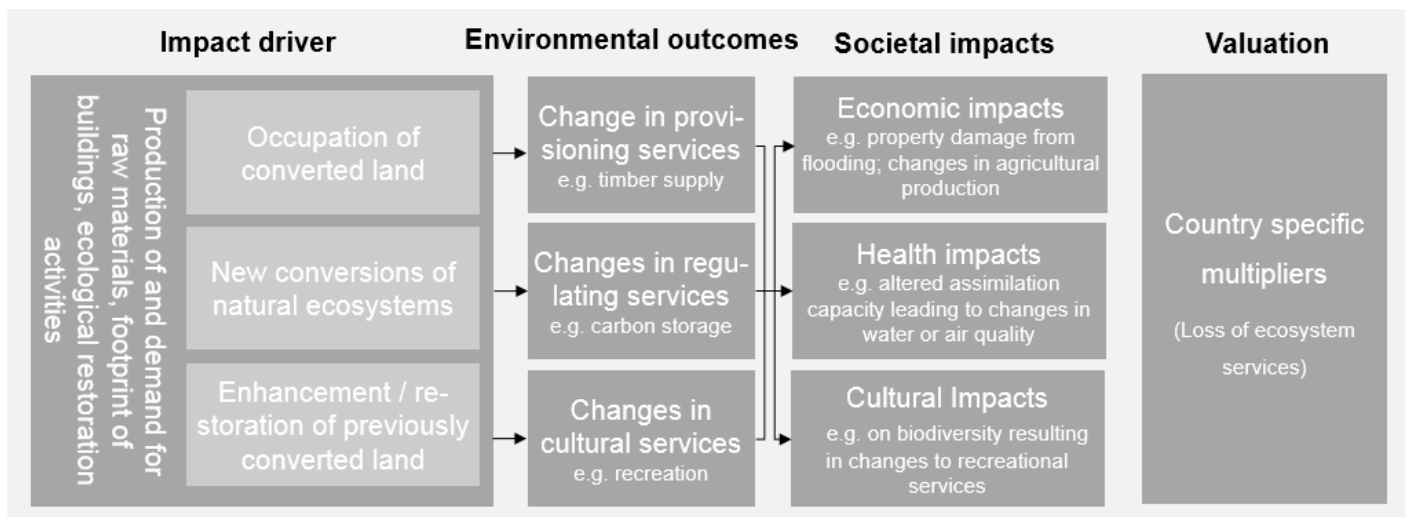


Diagram 15: Impact pathway ‘Land use’

## Annex 2 – Key methodological considerations

### Input-output models

(Multi-regional) input-output models represent the linkages and interdependencies between different sectors (and regions) within an economy. The underlying datasets are based on real financial data, sourced by governments and other scientific institutions. Traditionally, these models have been used to investigate the knock-on economic impacts of a company's activities on the rest of the economy. However, by extending these models to also consider environmental and socio-economic indicators, it is possible to quantify a broader range of impacts across a company's supply chain. These impacts can then be monetized to reflect corporate-driven benefits and costs to the economy, the environment and society as a whole. This approach enables a pragmatic quantification of associated impacts across our entire supply chain and downstream customer industries. It should be noted however, that the results are based on secondary industry data and thus reflect the average impacts across the industries implicated in our value chain, and not the specific impacts of BASF's partners.

### Purchasing power parity

All financial capital flows were adjusted for differences in purchasing power parity (PPP) between countries to address the fact that the total change in welfare brought about by 1€ of spending differs from country to country. These adjustments were made using PPP conversion factors from the World Bank, and all values were stated in terms of German PPP. The decision to apply PPP conversion factors was taken to align BASF's Value-to-Society results across all countries as well as impact categories including non-financial capital flows where impacts are already implicitly adjusted to control for differences in income and PPP in different countries. BASF's Value-to-Society results thus represent the 'real' long-term value of our total impact on society in terms of the monetary value of changes to the welfare of individuals. In order to avoid short-term fluctuation related to more volatile exchange rates, welfare adjustments were frozen to 2011, the base year of input-output model data.

### Social cost of carbon

The social cost of carbon (SCC) represents the current and future economic damages from the emission of one ton of GHGs. The SCC has been subject to a significant amount of research. Hence, to produce a representative estimate of the SCC for use in BASF's Value-to-Society approach, PwC used the results from a meta-analysis of the extensive academic literature that already exists on the subject. From this analysis, we have chosen a SCC of €77 (based on 2017 numbers) for one ton of GHG emissions.

The profile of anticipated climate change damages is weighted into the future, and GHG emissions reside in the atmosphere for a limited period. Therefore, the expected climate impact of additional tons of CO<sub>2</sub>e rises over time. As recommended by the UN's International Panel on Climate Change (IPCC) it is assumed that the real SCC increases by 3% per year.

## Annex 3 – Social impact valuation

### Human capital

Human capital, from BASF's own operations, is valued using an approach which estimates the likely wage uplift derived from training. This increase in earnings potential represents a proxy for the wellbeing benefits enabled by increased human capital from training. A four-step approach is applied:

- The baseline of expected wage growth for employees over their careers, assuming they did not complete the training, is derived from the national average wage projections of people with the equivalent level of training and education. The baseline assumes that average wages increase in line with projected productivity growth and align with observed wage growth with age. It is assumed that employees will stop working when they reach national retirement age. Productivity projections from Thomson Reuters and the average wage data from national governments are used.
- The incremental wage uplift attributable to training provided is estimated based on the difference between the average expected earnings of an employee who has not completed the training and the estimated average expected earnings after completing the training. See diagram below. The total future increased earnings are discounted to represent the value in current prices.
- BASF both fully funds and co-funds its training, therefore increased earnings associated with the training are allocated to BASF based on the proportion of cost of the training it contributes.
- The value of the increased wages while the employee is working for BASF are accounted for in BASF's wage impact. Therefore, to avoid double counting with the impact category wages, only the value generated by workers who leave BASF is consolidated. The rate at which employees leave BASF is based on its historic annual leaving rate.

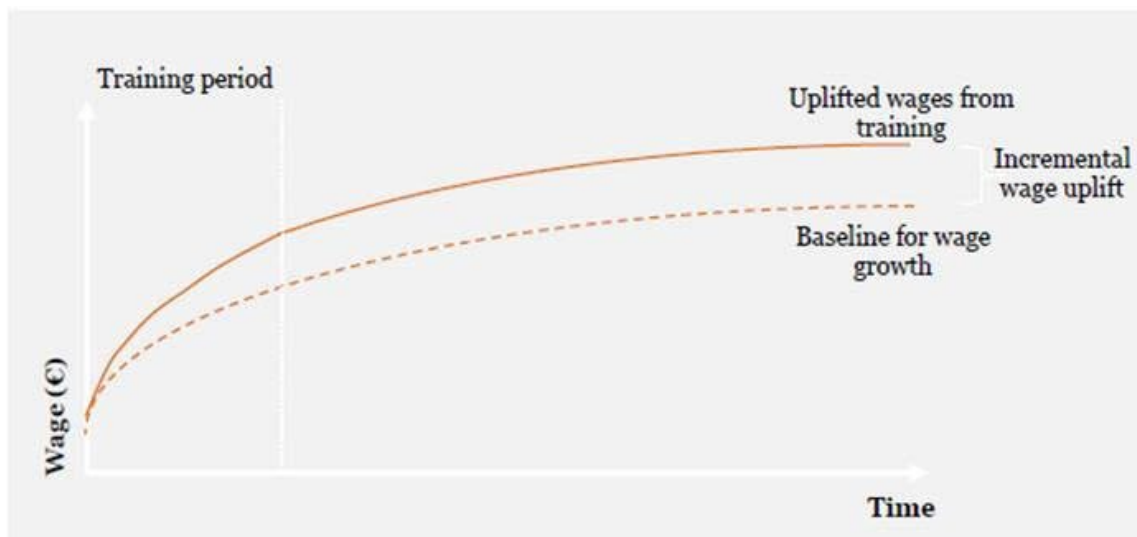


Diagram 16: Estimate incremental wage uplift from training

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## Health and safety

Health and safety incidents occur both in BASF's operations and across its value chain. These incidents can be categorized into different types of injuries and illnesses that have different impacts on a person's wellbeing, cost of recovery and ability to contribute to the economy. Three aspects of impact on the person are included when valuing the health and safety impact for each incident category:

- Willingness to pay to avoid a fatality, injury or illness: the value to people of the pain, grief and suffering from incidents.
- Medical resource costs: The costs of treatment and rehabilitation are used to represent the cost to society of providing medical support.
- Economic output: In case of fatalities the valuation considers the lost consumption from lifetime earnings and costs to society from foregone savings and consumption of others. In case of injuries or illnesses the impact of the person not being available to the national workforce is estimated.

These values are based on data from International Labor Organization, UK government and adjusted for differing costs across countries using World Bank data.

## Annex 4 – Valuation coefficients (excerpt of applied valuation coefficients 2017)

### Financial indicators (Profits, amortization, taxes, wages and benefits)

The financial indicator impacts are PPP-adjusted. In this way impacts represent the purchasing power of the financial gains in different countries. The data provided by The World Bank is referenced to US PPP.

However, in order to calculate country specific PPP conversion factors that relate to BASF, the country specific ratios given by The World Bank have been divided by the German value of the original data set in order to change the reference country from the US to Germany. As a result, the financial impacts for Germany after the PPP adjustment remain unchanged.

Applied PPP conversion factors range from 0.7 to 3.8 depending on the country.

### Greenhouse gases (GHGs)

The value or costs of GHG emissions to society through climate change is independent of the location of the source of the emission. Therefore, the social cost of carbon applied is the same for all locations.

Applied valuation coefficient (multiplier) is €77 for societal costs per tCO<sub>2e</sub>.

### Land use

This refers to the value of the impact from the loss of ecosystem services associated with land being converted from its pristine state to today's use. The range in values is driven, in the main, by differences in the pristine ecosystem services between countries. For example, some countries' land areas are dominated by desert and arid land, whereas other countries' land areas are covered by tropical forests and coastal wetlands.

Applied valuation coefficients (multipliers) range from €47 to €12,641 per hectare for societal costs depending on the country.

### Air pollution

Particulate matter 2.5 (PM<sub>2.5</sub>) is one of the six main pollutants taken into account. Four sub-categories are applied at country level: Urban, peri-urban, rural, transport. The value of the impact of one kg of PM<sub>2.5</sub> is driven by differences in various factors between countries, including population density and weather conditions.

Applied valuation coefficients (multipliers) for PM<sub>2.5</sub> emitted in a peri-urban context (e.g. emission in a manufacturing facility close to a small town) range from €1 to €163 per kg of PM<sub>2.5</sub>, depending on the country.

## Annex 5 – Assurance Report of the Independent Auditor

# Assurance Report of the Independent Auditor

To the Board of Executive Directors of BASF SE, Ludwigshafen

We have been engaged to perform an independent limited assurance engagement on whether the process for measuring the BASF Group's (hereinafter "BASF") Value-to-Society had been implemented as described in the "Value-to-Society – Measurement and monetary valuation of BASF's impacts in society" method paper (hereinafter: "Method Paper"), available at [https://www.basf.com/documents/corp/en/sustainability/management-and-instruments/quantifying-sustainability/we-create-value/BASFs\\_Value-to-Society\\_Method\\_Paper.pdf](https://www.basf.com/documents/corp/en/sustainability/management-and-instruments/quantifying-sustainability/we-create-value/BASFs_Value-to-Society_Method_Paper.pdf), for the reporting period from January 1 to December 31, 2017.

### Management's Responsibility

The legal representatives of BASF are responsible for the proper design and development of the process for measuring the BASF Value-to-Society in accordance with the defined measurement criteria and methodology definitions set forth in the Method Paper.

This responsibility of the legal representatives includes the selection and application of appropriate methods to implement the process for measuring the BASF Value-to-Society. Furthermore, this responsibility includes designing, implementing and maintaining internal controls relevant for the process for measuring the BASF Value-to-Society in a way that is free of – intended or unintended – material misstatements.

### Independence and Quality Assurance on the Part of the Auditing Firm

We are independent from the entity in accordance with the requirements of independence and quality assurance set out in legal provisions and professional pronouncements and have fulfilled our additional professional obligations in accordance with these requirements.

Our audit firm applies the national statutory provisions and professional pronouncements for quality assurance, in particular the Professional Code for German Public Auditors and Chartered Accountants (in Germany) and the quality assurance standard of the German Institute of Public Auditors (Institut der Wirtschaftsprüfer, IDW) regarding quality assurance requirements in audit practice (IDW QS 1).

### Practitioner's Responsibility

Our responsibility is to express a conclusion based on our work performed within our limited assurance engagement on whether the process for measuring the BASF Value-to-Society had been implemented as described in the Method Paper for the reporting period from

January 1 to December 31, 2017.

We conducted our work in accordance with the International Standard on Assurance Engagements (ISAE) 3000 (Revised): “Assurance Engagements Other than Audits or Reviews of Historical Financial Information” published by IAASB. This standard requires that we plan and perform the assurance engagement to obtain limited assurance of whether any matters have come to our attention that cause us to believe that the process for measuring the BASF Value-to-Society had not been implemented, for the reporting period from January 1 to December 31, 2017, in all material respects, as described in the Method Paper. In a limited assurance engagement, the evidence gathering procedures are more limited than in a reasonable assurance engagement, and therefore less assurance is obtained than in a reasonable assurance engagement. The choice of audit procedures is subject to the auditor’s own judgement.

Within the scope of our engagement, we performed the following procedures:

- Obtain an understanding of the approach for measuring the BASF Value-to-Society with regards to the selection and collection of input factors, modelling of upstream and downstream effects (assumptions, estimations, external data sources) as well as for the monetization of quantitative impacts of considered indicators
- Evaluation of documentation and process descriptions of BASF and the third party service provider
- Evaluation of the process and internal controls of BASF to select and collect input data (primary and secondary data), which are forwarded to the third party service provider who quantifies impacts
- Reconciliation of the consistency of the input data (primary data) with the data points used in financial reporting and integrated reporting of BASF for the business year from January 1 to December 31, 2017
- Analytical evaluation of the process and internal controls of the third party service provider to process BASF input data in its systems (data consistency)
- Obtain an understanding of the quantification models used by the third party service provider to quantify upstream and downstream impacts as well as methods and applied parameters to monetize impacts
- Evaluation of the process to assess the impacts, including the selection process of applied parameters
- Evaluation of internal controls of the third party service provider to ensure the arithmetical correctness of calculated quantitative impacts and monetized results

(obtaining a declaration on quality management)

- Inquiries of personnel at BASF responsible for measuring the BASF Value-to-Society to develop an understanding of the plausibility and completeness of calculated results regarding economic, social, and environmental impacts
- Assessment of the appropriateness of the explanatory notes on the process for measuring the BASF Value-to-Society in the Method Paper

## Conclusion

Based on the procedures performed and the evidence obtained, nothing has come to our attention that causes us to believe that the processes for measuring the BASF Value-to-Society for the reporting period from January 1 to December 31, 2017, had not been implemented, in all material aspects, as described in the Method Paper.

## Restriction of Use/Clause on General Engagement Terms

This assurance report is issued for the purposes of the Board of Executive Directors of BASF SE, Ludwigshafen, only. We assume no responsibility with regard to any third parties.

Our assignment for the Board of Executive Directors of BASF SE, Ludwigshafen, and professional liability is governed by the General Engagement Terms for Wirtschaftsprüfer (German Public Auditors) and Wirtschaftsprüfungsgesellschaften (German Public Audit Firms) (Allgemeine Auftragsbedingungen für Wirtschaftsprüfer und Wirtschaftsprüfungsgesellschaften) in the version dated January 1, 2017 ([https://www.kpmg.de/bescheinigungen/lib/aab\\_english.pdf](https://www.kpmg.de/bescheinigungen/lib/aab_english.pdf)). By reading and using the information contained in this assurance report, each recipient confirms having taken note of provisions of the General Engagement Terms (including the limitation of our liability for negligence to EUR 4 million as stipulated in No. 9) and accepts the validity of the attached General Engagement Terms with respect to us.

Duesseldorf, December 13, 2018

KPMG AG

Wirtschaftsprüfungsgesellschaft

Laue

Wirtschaftsprüfer

[German Public Auditor]

Hell