

Value-to-Society

Quantification and monetary valuation of BASF's impacts on 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 going beyond established qualitative and quantitative assessments. For the first time, we quantify and value the financial and non-financial external effects of our business activities in society in a common unit – in euro. The results reflect our ‘real’ value contribution, our benefits and costs to society; e.g. the societal costs of carbon emissions. In BASF’s Value-to-Society we assess our relevant impacts along our entire supply chain, our own operations, and our customer industries. The impacts of our products in their consumer use phase and end-of-life are covered case-by-case.

Our holistic approach provides the following benefits:

- Macro-societal perspective on the external effects of our company
- Mapping of our own impacts and of our partners along the value chain
- Comparability of financial and non-financial impacts in a language business understands
- Better understanding of economic, social, and environmental interdependencies
- Pragmatic, efficient, transferable approach and auditable results

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 provides valuable insights to inform communications, reporting, progress monitoring, materiality analyses, risk management, and business decision-making.

BASF’s Value-to-Society approach supports our understanding and monitoring of our contribution to a sustainable future by quantifying and valuing impacts on society in monetary terms.

Table of Contents

1. Introduction.....	p.3
2. Scope.....	p.3
2.1 Value chain coverage.....	p.3
2.2 Impact categories.....	p.4
3. BASF’s Value-to-Society – Results at corporate level.....	p.5
4. Overview of data and methodologies (corporate level).....	p.6
4.1 BASF’s own operations.....	p.7
4.2 Supplier and customer pathways.....	p.7
4.3 Valuation techniques.....	p.8
4.4 Mitigating distortive effects.....	p.11
5. Summary and application fields.....	p.12
Feedback by our stakeholders.....	p.14
Annex 1 – Impact pathways.....	p.15
Annex 2 – Key methodological considerations.....	p.21
Annex 3 – Valuation coefficients (excerpt).....	p.22

1. Introduction

This paper is intended for impact valuation program managers and sustainability leaders. 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 4.2) and the mitigation of distortive effects (chapter 4.4). 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 about the approach. 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. 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.

2.1 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:

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

Our ambition: Assess BASF's value contribution to society as holistically and specifically as possible based on the principles of materiality, practicability, and feasibility.

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.

2.2 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: Entire supply chain, our own operations, and production processes in customer industries.

The baseline model includes the following impact categories

- Economic (EBIDA): Profits (incl. 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.

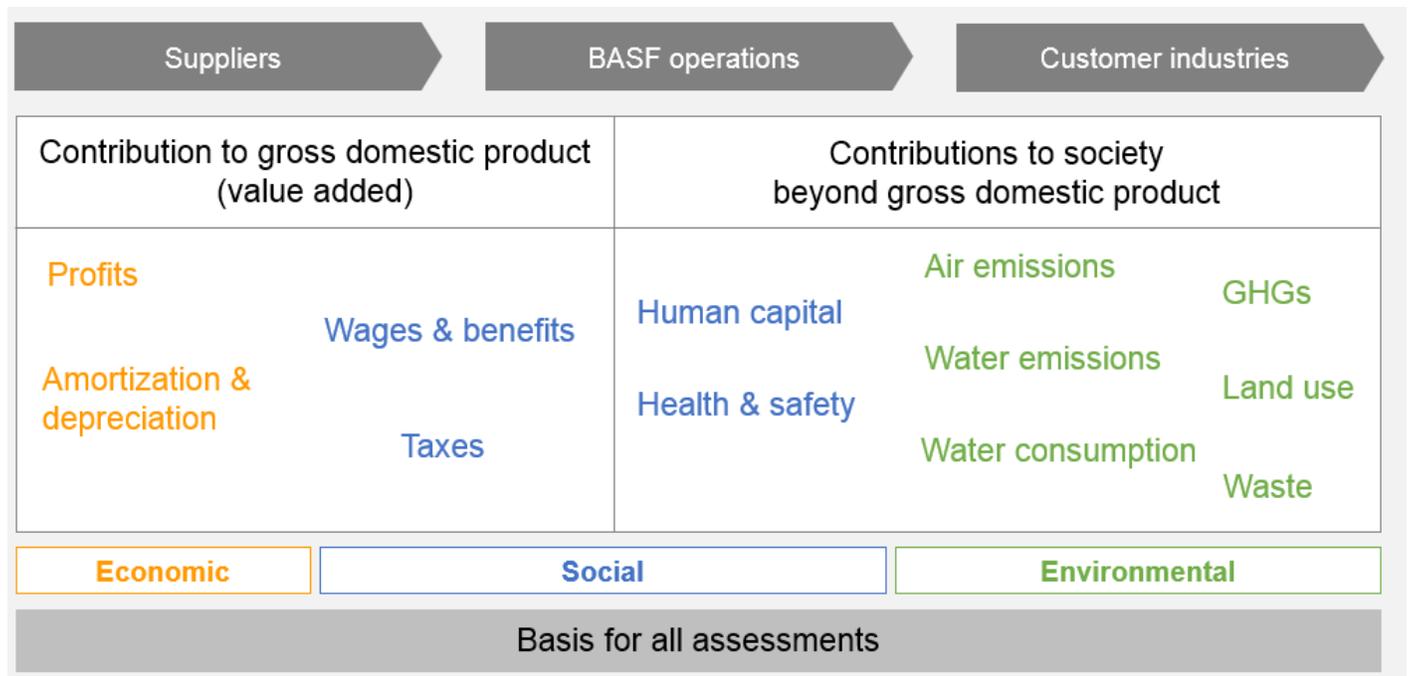


Diagram 1: Scope of BASF’s Value-to-Society approach at corporate level.

Core economic, social, and environmental benefits and costs to society are considered in all assessments. If material and measurable, additional impacts are also taken into account.

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.

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

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

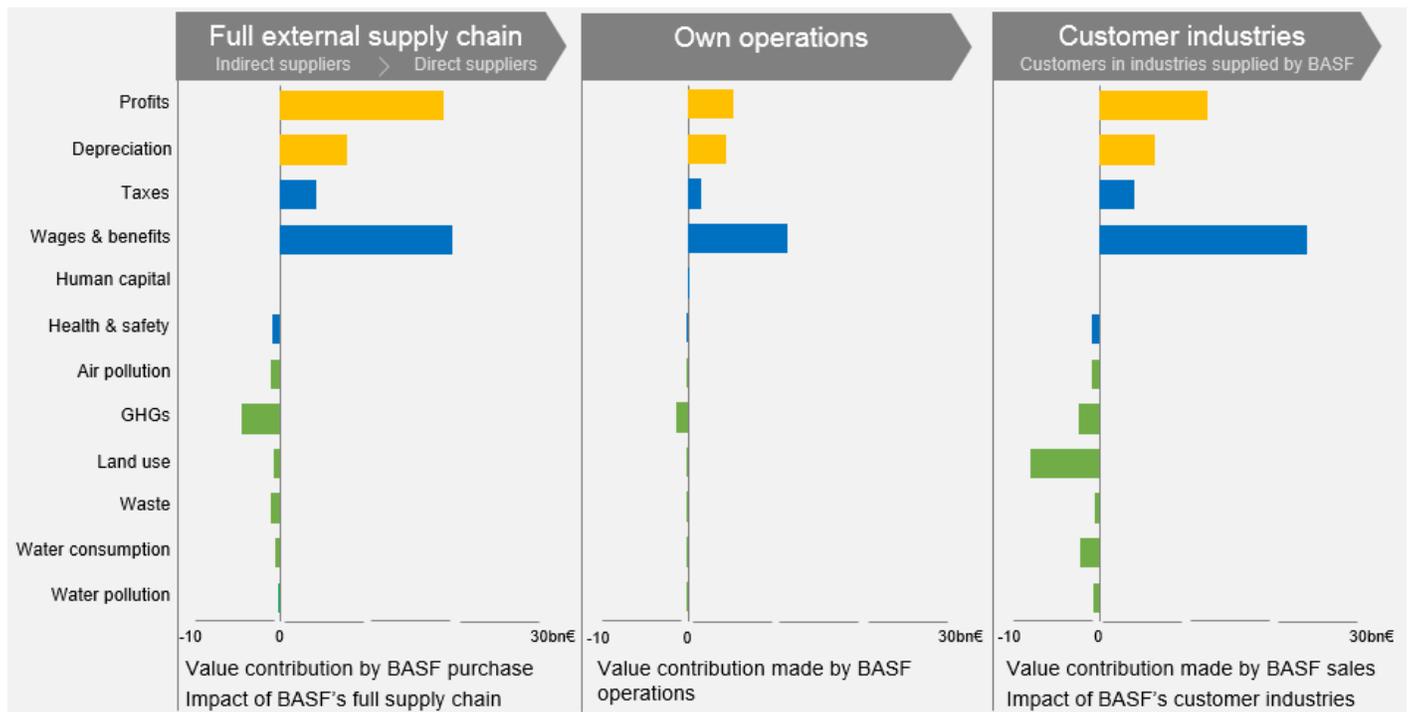


Diagram 2: Results of BASF's Value-to-Society assessment BASF Group 2016.

According to our analysis, our value contribution to society has been net positive from 2013 to 2016, 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, human capital. Negative impacts are health and safety incidents as well as impacts on the environment.

**BASF's Value-to-Society contribution is net positive.
Our business activities provide and enable higher benefits than costs to society in each step of the value chain.**

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.

4. 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 on society is the availability of data linking business activities to quantities of impacts (e.g. wages paid or GHGs emitted). As direct, primary data are 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 datasets enable a pragmatic quantification of impacts based on the methods of aggregation for our own operations and 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.

BASF primary data are used to measure our operational impact on society. For suppliers and customer industries, publicly available industry data are applied leading to indicative results.

4.1 BASF's own operations

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

4.2 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 that is 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.

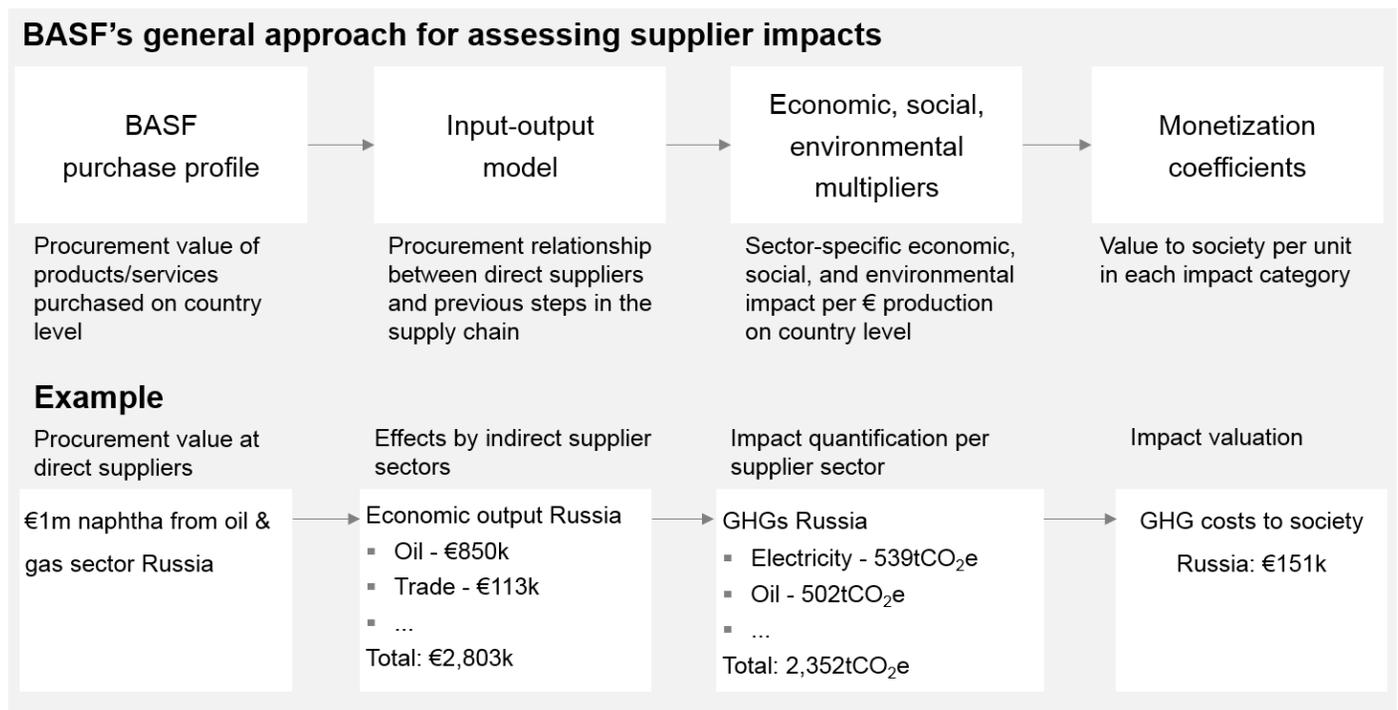


Diagram 4: Calculation of supplier pathway.

We generate direct benefits and costs to society. Enabled value creation by suppliers and customers are also considered in BASF's holistic Value-to-Society approach.

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, our supply share into a specific customer industry and country is used to quantify the impacts of customer industries’ activities which are enabled by our product applications.

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

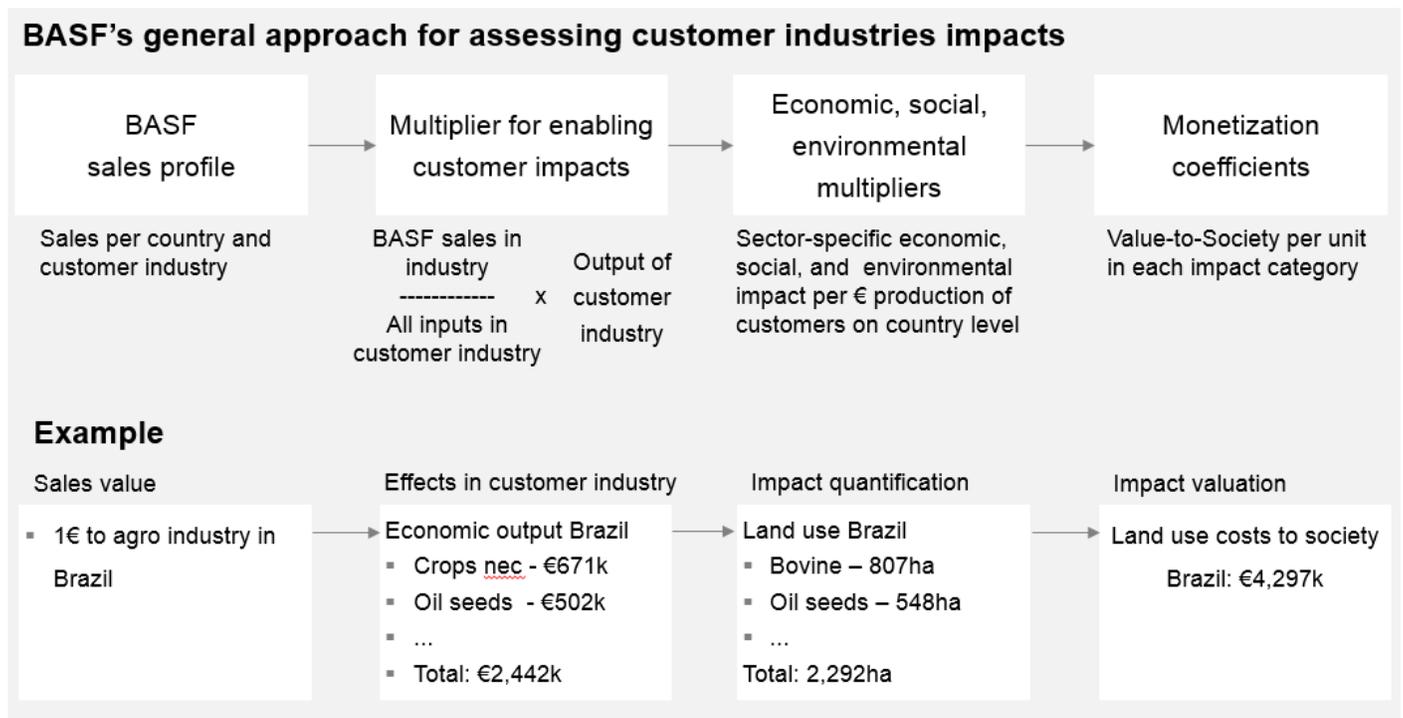


Diagram 5: Calculation of customer pathway.

4.3 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 exceeds 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).

BASF’s Value-to-Society approach quantifies and values direct impacts of own operations and enabled benefits and costs through purchase and sales activities. We estimate the results as directionally correct.

- 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 a better understanding of their interdependencies along the value chain.

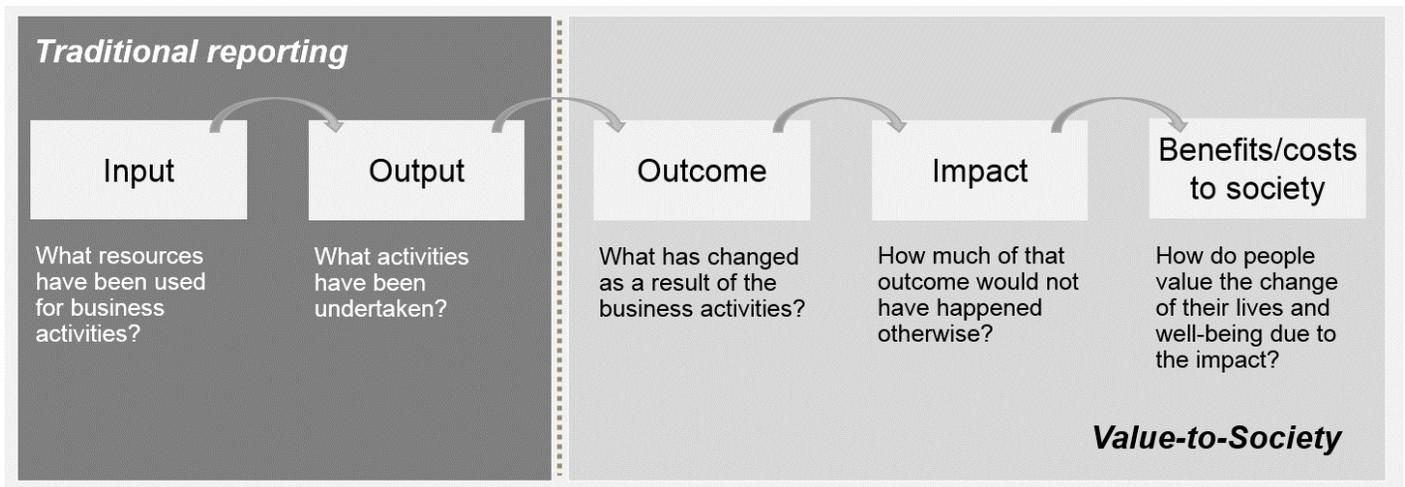


Diagram 6: The new aspects of BASF's Value-to-Society compared to traditional reporting.

4.3.1 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.
- 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 1tCO₂e 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).

BASF's Value-to-Society approach goes beyond traditional reporting by quantifying the impacts of our business activities on society and by valuing their effect on human health and wellbeing.

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.

4.3.2 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.

4.3.3 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. 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 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.

**BASF's Value-to-Society approach values quantified impacts in two ways:
For financial flows purchase power parity factors, for non-financial flows
revealed and stated preferences as well as cost-based approaches.**

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>.

4.4 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 affects:

- 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: 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 of 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, m³, MWh); and 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.

BASF's Value-to-Society strives to assess the 'real' value contribution of its business activities. Therefore, distortive financial effects are mitigated.

Volatility in exchange rates over time

The results of BASF's Value-to-Society are expressed in euro. 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, 62€ are applied as multiplier for 1t GHG emissions in 2013. If regular exchange rate conversion were used, this multiplier would increase by 25% in 2015. This effect should also be considered distortive as changes in the monetary valuation of greenhouse gases should 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, exchange rate conversion for monetization factors was frozen to 2013, the first year of impact assessment.

To mitigate changes due to pure 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).

5. 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 and Social Capital protocols, the Impact Valuation Roundtable, or within ISO.

By providing a new, macro-societal perspective on our business, Value-to-Society results complement established tools and processes for positioning, monitoring, decision making.

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

BASF makes no express or implied warranty or representation in relation to any information or data contained in the BASF Value-to-Society assessments. Therefore, none of BASF or its representatives will have any liability whatsoever in negligence or otherwise for any loss arising from any use of the BASF Value-to-Society approach or otherwise arising in connection with this document or any other information or material comprised in or derived from BASF Value-to-Society assessments.

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Feedback by our stakeholders

'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

'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

'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

"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

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.

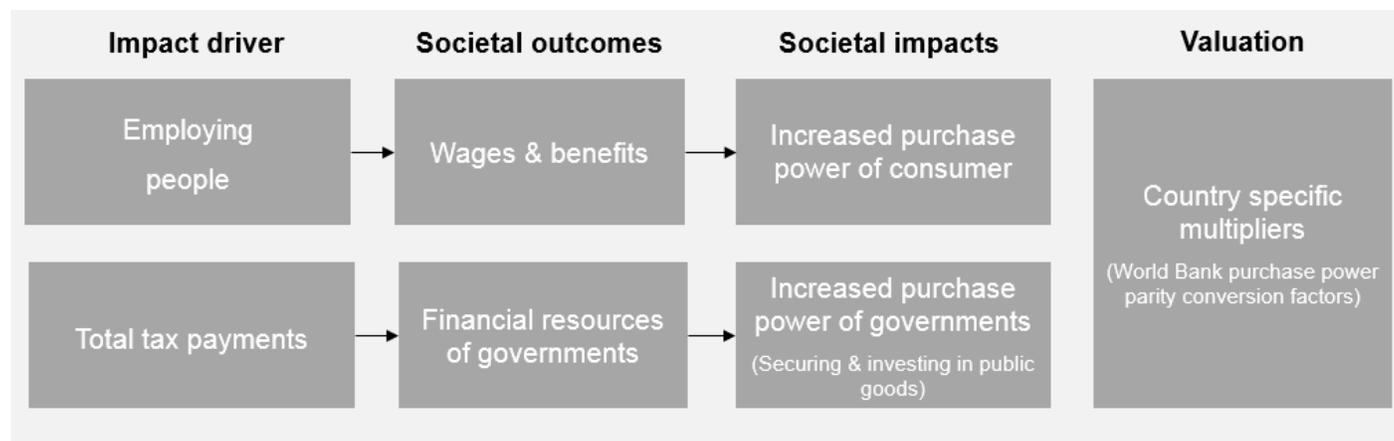
Economic impacts – *Profits, amortization, depreciation (EBIDA)*

In order to quantify benefits to society provided by BASF’s corporate earnings, the EBIDA is taking 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 World Bank’s purchase power parity conversion factors.

Social impacts

Taxes, wages and benefits

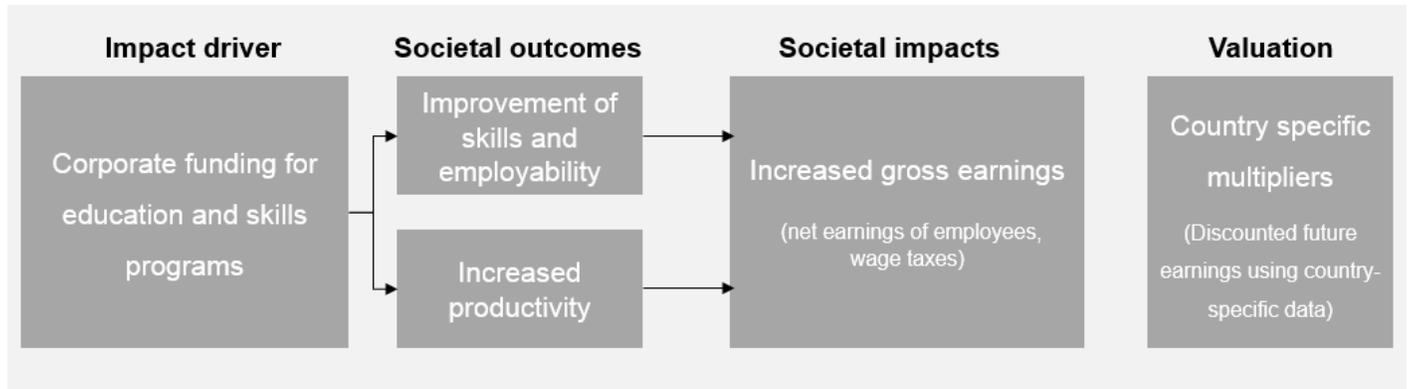
In order to quantify the benefits to society provided by BASF due to public dues and employment, total tax payment as well as wages and benefits are taken into account. The respective benefits to society are monetized by applying World Bank’s country-specific purchase power parity conversion factors.



Human Capital

In order to quantify and value the benefits to society provided by human capital, corporate development programs or 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.

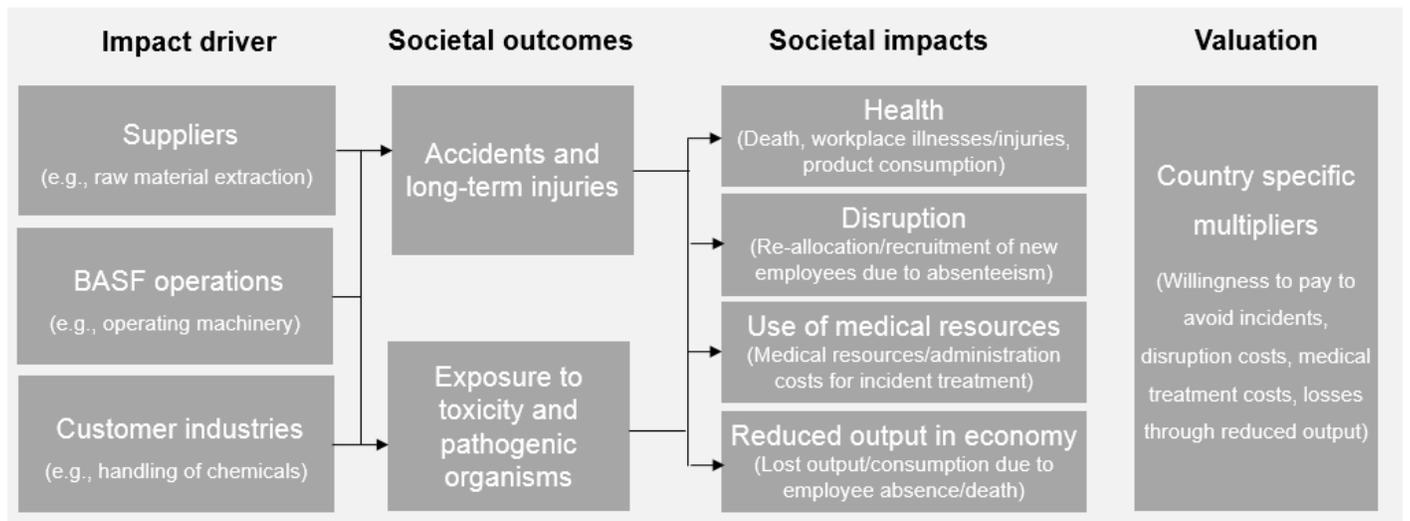
BASF training data and staff leaving rate are used for quantification. The other parts of BASF’s value chain are not covered due to a lack of data availability.



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. This includes 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.

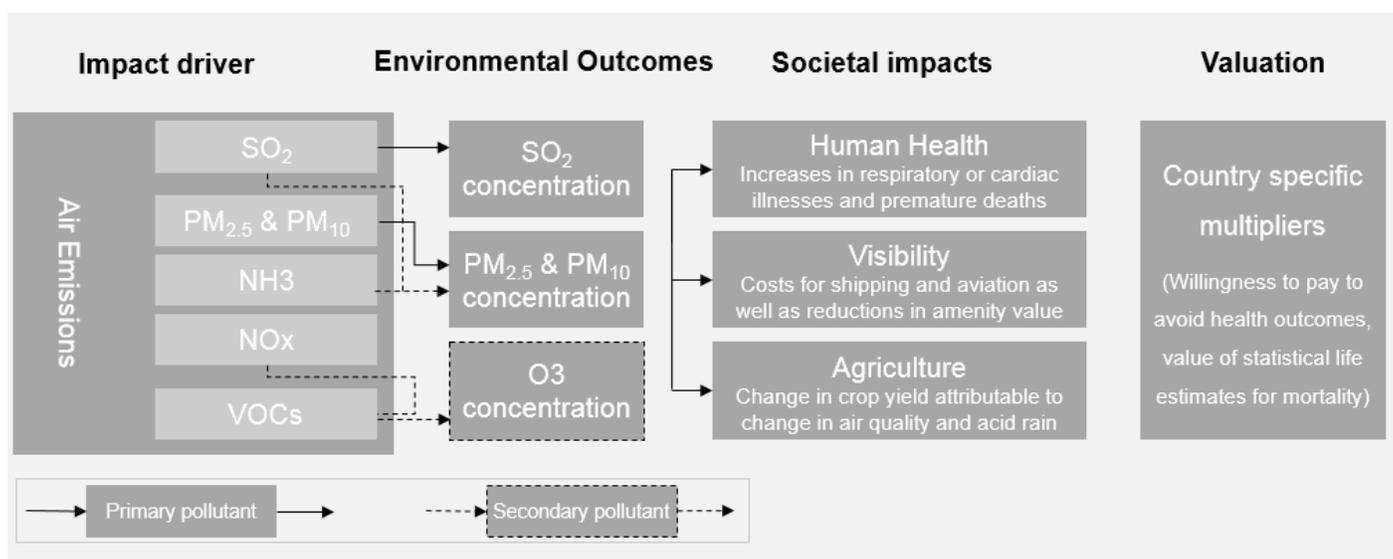


Environmental impacts

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.

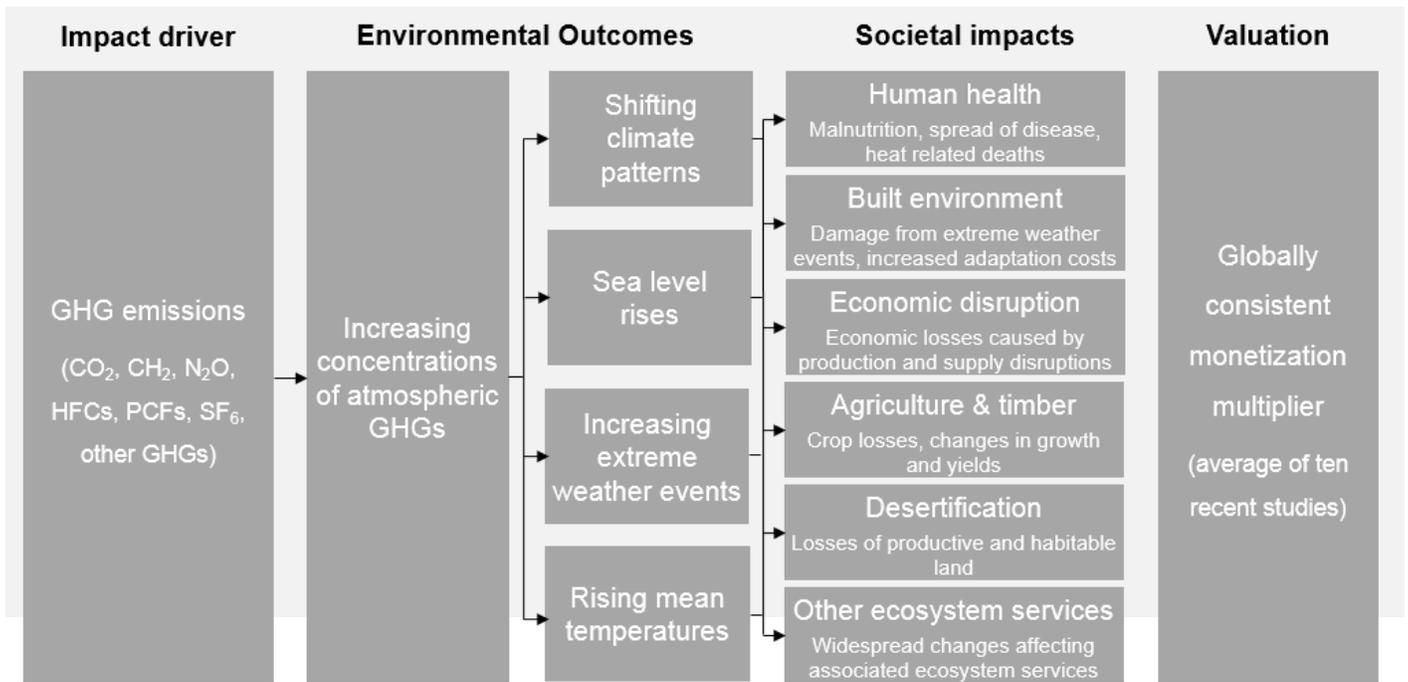
BASF quantifies changes in the specified pollutant concentrations using an air dispersion model and the mass of air emissions from corporate activities along the value chain. The effect of increased concentrations on human health is modelled using dose-response functions for respiratory diseases and 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 the quantified mass of each pollutant across BASF supply chain.



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 impacts on: human health, built environment, economic disruption, agriculture and timber, or desertification.

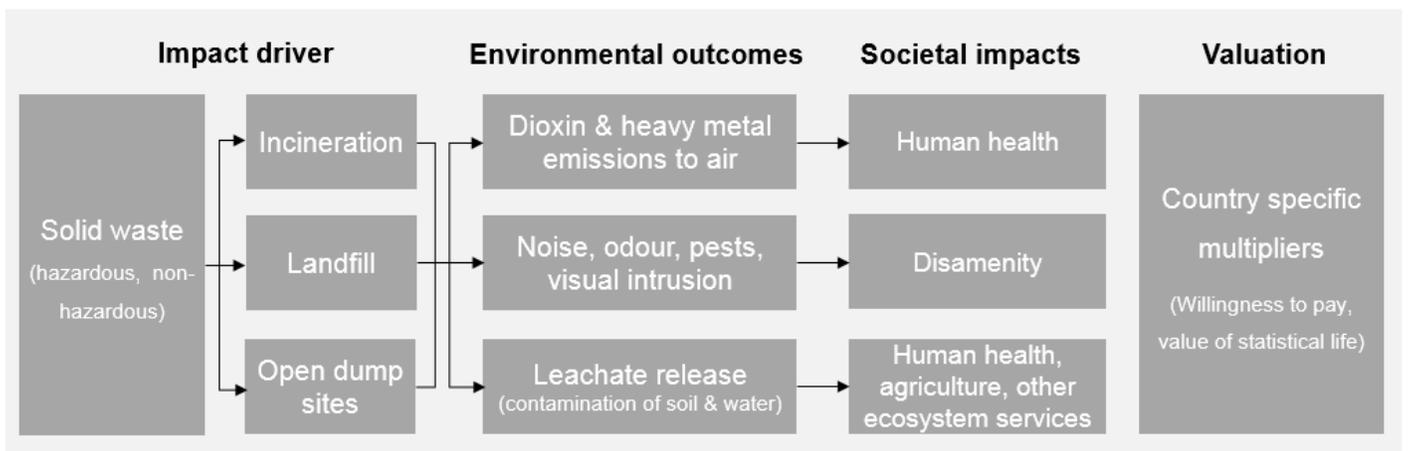
BASF quantifies the resulting environmental outcomes using the mass of GHG emissions from corporate activities along the value chain in CO₂ equivalents. The respective costs to society are valued applying a global coefficient based on a meta-analysis of recent Social Cost of Carbon estimates.



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, other emissions to air, noise, odour, or visual intrusion. These outcomes lead to climate change and impacts on society such as human health, and disamenity.

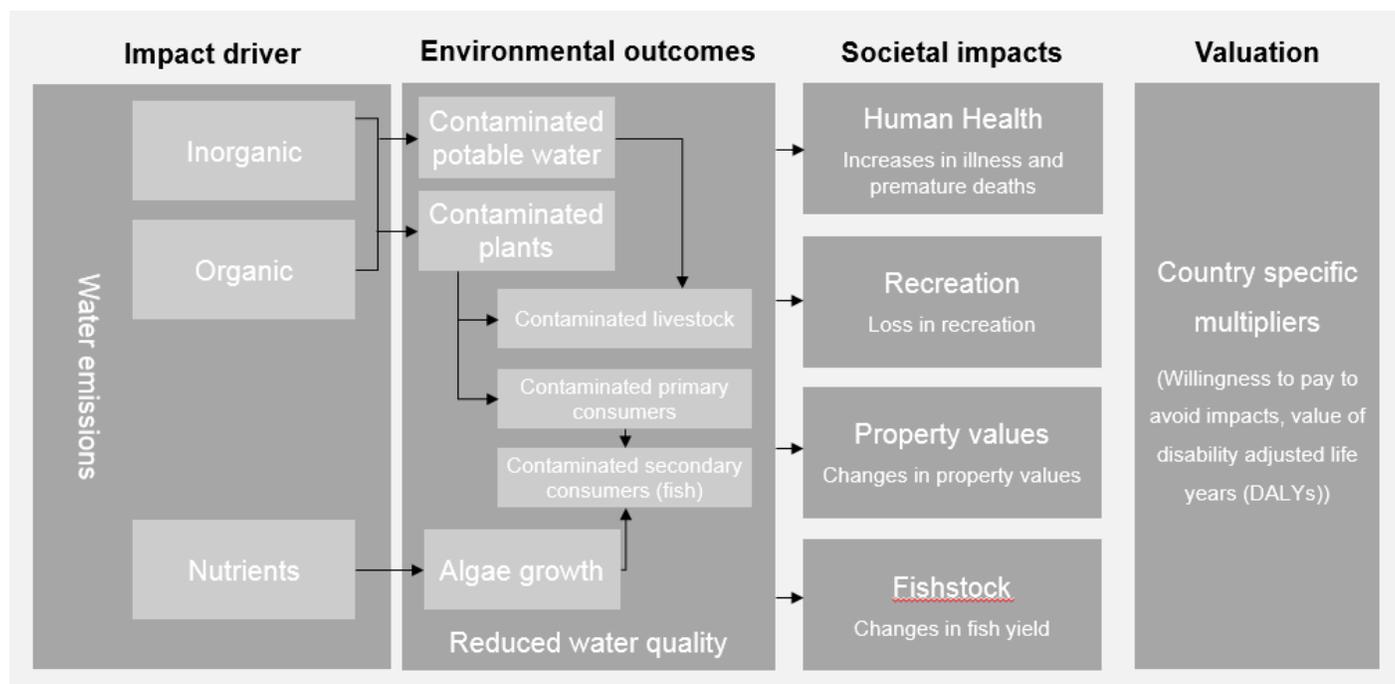
BASF quantifies environmental changes using different approaches for respective outcomes such as a risk-based approach in case of leachate or using a model by the Intergovernmental Panel on Climate Change (IPCC) to estimate the GHG emissions as landfill waste decomposes. National level data is collected 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.



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 to water are taken into account. For nutrient discharges, nitrogen and phosphorus are considered. For all other discharges, sixteen main pollutants are covered such as arsenic or mercury. Emitting these pollutants reduces the water quality affecting livestock and water consumers. This leads to various impacts on people such as human health, loss in recreation, changes of property values, or reduction of fish stocks.

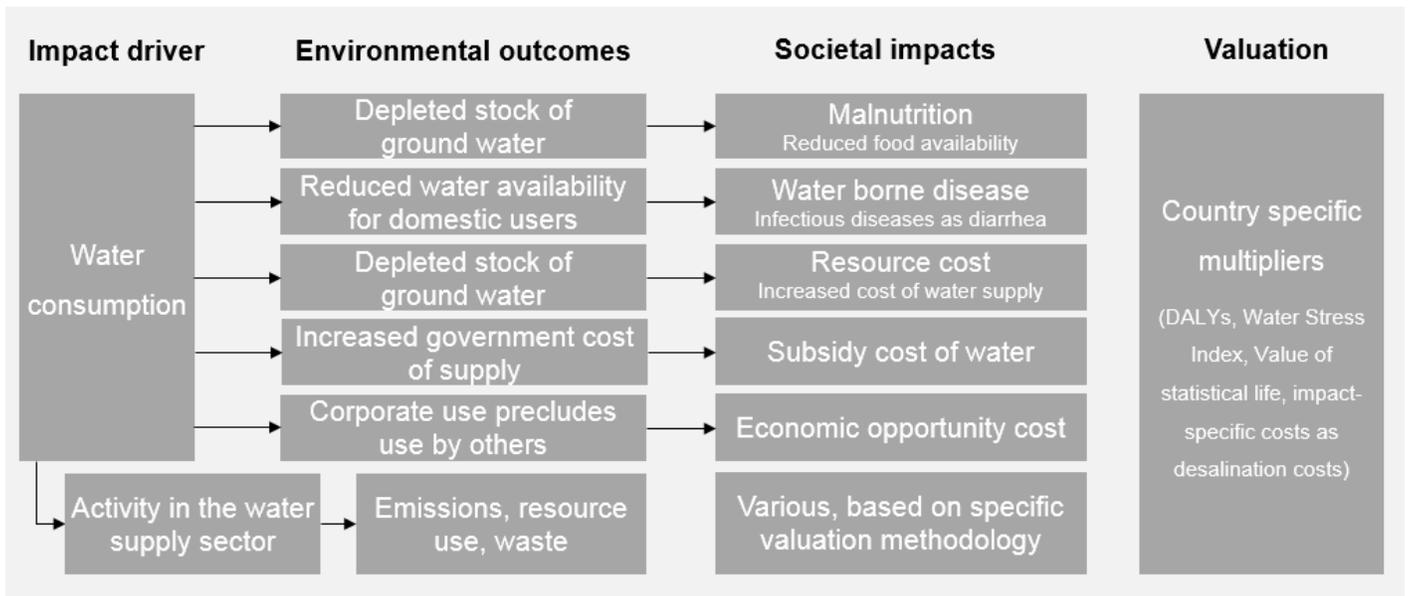
BASF quantifies the environmental outcomes caused by emissions to water using a model based on the chemical fate and likelihood of human exposure, which considers the different characteristics of pollutants. The costs to society of each pollutant that is emitted to water are estimated in country-specific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



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.

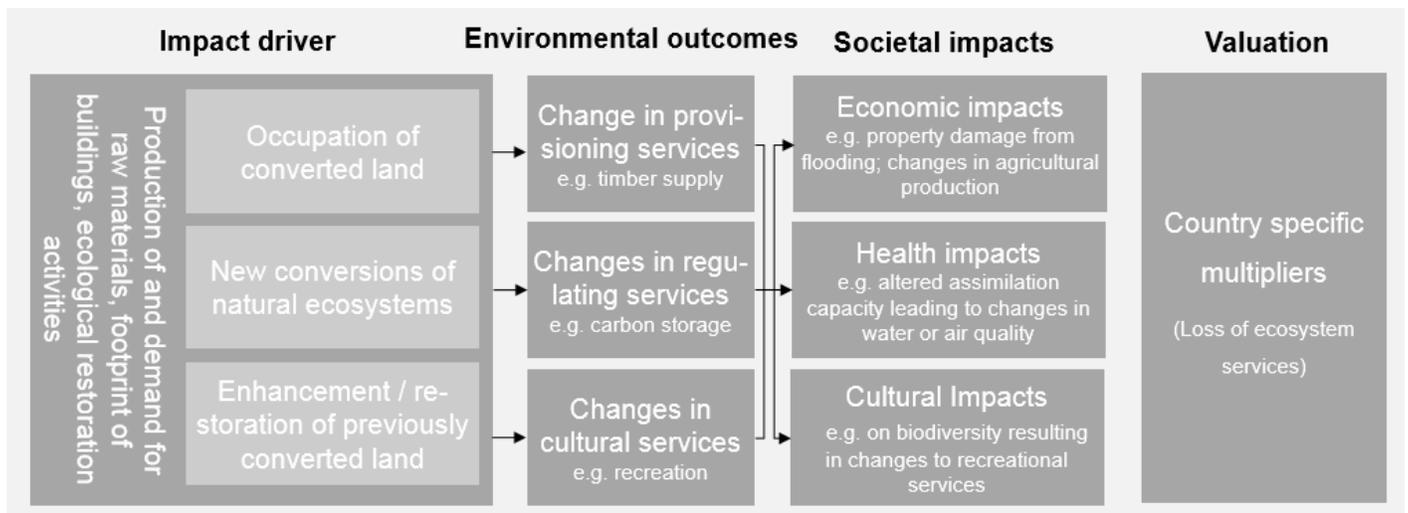
BASF quantifies the environmental outcomes caused by water consumption using the volume of corporate water consumption and the respective water stress level based on a water stress index (WSI). Moreover, the depletion rate and depletion time are taken into account. The costs to society of water consumption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



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, 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.



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 modeling 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 business 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 by academics and government agencies. 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 which already exists on the subject. From this analysis, we have chosen a SCC of 70€ (EUR 2015) for one ton of GHG emissions in 2015.

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 an additional tons of CO₂e rises over time. As recommended by the IPCC it is assumed that the real SCC increases every year by 3%.

Annex 3 – Valuation coefficients (excerpt of applied valuation coefficients 2015)

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

The financial indicator impacts are purchase power parity (PPP) adjusted so the impact represents the purchasing power of the financial gains in different countries. The data provided by the Worldbank is referenced to the US. In order to calculate country specific adjustment factors for a PPP adjustment that relates to the German perspective of BASF, the country specific ratios given by the Worldbank have been divided by the German value of the original data set, 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 valuation coefficients (multipliers) range from 0.26 to 1.47 depending on the country.

Greenhouse gases (GHGs)

The value or costs of GHG emissions top 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 -70€ per tCO₂e (EUR 2015).

Land use

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 -16€ to -3,920€ per Hectare (EUR 2015) depending on the country.

Air pollution

PM_{2.5} 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_{2.5}, is driven by differences in various factors between countries, including population density and weather conditions.

Applied valuation coefficients (multipliers) for PM_{2.5} emitted in a peri-urban context (e.g. emission in a manufacturing facility close to small town) range from -0.19€ to -94.52€ per kg of PM_{2.5} (EUR 2015), depending on the country.