TEXTE
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Contributions to the sustainable development strategy: reduction of resource consumption in the chemical sector by instruments of sustainable chemistry

Summary

For our Environment

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TEXTE 38/2017

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Contributions to the sustainable development strategy: reduction of resource consumption in the chemical sector by instruments of sustainable chemistry

by

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Abstract

Sustainable chemistry can make a significant contribution to sustainable development. However, a clear understanding of what actually constitutes sustainable chemistry is still lacking. Furthermore, there is a lack of direction and prioritization of the various activities which have developed in this field in the last few decades. Against this background, the research project "Contributions to the sustainable development strategy: reduction of resource consumption in the chemical sector by instruments of sustainable chemistry" had the following goals:

- development of a concept of sustainable chemistry;
- development of indicators by means of which sustainability in chemistry can be measured and testing of these indicators on the basis of case studies; and
- assessment of potential savings through instruments of sustainable chemistry.

The report elaborates the approach for the development of the concept of sustainable chemistry, the indicators, their application and the map of sustainable chemistry. Important reference points for this work are the United Nations' Sustainable Development Goals and the International Sustainable Chemistry Collaborative Centre ISC3 which is to be set up soon. This short version summarizes the main findings. Details are given in the long version of the final report (in German).

Kurzbeschreibung

Nachhaltige Chemie kann einen bedeutenden Beitrag zur nachhaltigen Entwicklung leisten. Derzeit fehlt es allerdings an einem klaren Verständnis, was nachhaltige Chemie ist. Außerdem mangelt es an einer Ausrichtung und Schwerpunktsetzung der unterschiedlichen Aktivitäten, die sich in diesem Feld in den letzten Jahrzehnten entwickelt haben. Vor diesem Hintergrund hatte das Forschungsprojekt „Beiträge zur Nachhaltigkeitsstrategie: Minderung des Ressourcenverbrauchs in der Chemiebranche durch Instrumente der nachhaltigen Chemie" folgende Ziele:

- Die Entwicklung eines Konzeptes der Nachhaltigen Chemie;
- die Entwicklung von Indikatoren, anhand derer Nachhaltigkeit in der Chemie gemessen werden kann und die Erprobung dieser Indikatoren anhand von Beispielen.
- die Abschätzung von Einsparpotenzialen durch Instrumente der nachhaltigen Chemie.

Dieser Bericht zeigt das Vorgehen für die Entwicklung des Konzeptes der Nachhaltigen Chemie. Der Indikatorensatz „Parameter der nachhaltigen Chemie" wird genannt, und Erfahrungen mit seiner Anwendung geschildert. Die Ergebnisdarstellung in Form der Landkarte der Nachhaltigen Chemie wird erklärt. Wichtige Bezugspunkte dieser Arbeiten sind die Nachhaltigkeitsziele der UN und das in Planung befindliche International Sustainable Chemistry Collaborative Center ISC3. Einzelheiten und Fallbeispiele werden in der Langfassung des Endberichtes wiedergegeben (in Deutsch).

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Glossary

ChL	Chemikalienleasing
BSB	Biochemischer Sauerstoffbedarf (engl. biochemical oxygen demand BOD)
CSB	Chemischer Sauerstoffbedarf (engl. chemical oxygen demand COD)
SDG	Sustainable Development Goal
EMAS	Eco-Management and Audit Scheme
HSP	Gefahrstoffpotenzial (engl. hazardous substance potential)
ISC3	International Sustainable Chemical Collaborative Centre
KMU	Kleine und mittlere Unternehmen
KPI	Betriebswirtschaftliche Kennzahlen (engl. key performance indicators)
MEG	Monoethylenglykol
NC	Nachhaltige Chemie
NCPC	National Cleaner Production Centre
OEF	Umweltfußabdruck von Organisationen, z. B. Unternehmen (engl. Organisation Environmental Footprint)
PEF	Umweltfußabdruck von Produkten (engl. Product Environmental Footprint)
PCF	Product Carbon Footprint (PCF)
PEFCRs	Product Environmental Footprint Category Rules
PER	Perchlorethylen/Tetrachlorethen
PET	Polyethylenterephthalat
PPK	Papier, Pappe und Karton
SAICM	Strategic Approach on International Chemicals Management
SDGs	Ziele nachhaltiger Entwicklung (engl. Sustainable Development Goals)
SETAC	Society of Environmental Toxicology and Chemistry
THG	Treibhausgase
TRI	Trichlorethylen
TRGS	Technischen Regel für Gefahrstoffe
UBA	Umweltbundesamt
UFOPLAN	Umweltforschungsplan
UN	Vereinte Nationen (United Nations)
UNIDO	United Nations Industrial Development Organization

1 Introduction: objectives of the project, structure of the short version

Sustainable chemistry can make a significant contribution to sustainable development. However, a clear understanding of what actually constitutes Sustainable Chemistry is still lacking. Furthermore, there is a lack of direction and prioritization of the various activities which have developed in this field in the last few decades. Against this background, the research project “Contributions to the sustainable development strategy: reduction of resource consumption in the chemical sector by instruments of sustainable chemistry” had four goals:"

- development of a concept of sustainable chemistry;
- development of indicators by means of which sustainability in chemistry can be measured;
- testing of these indicators on the basis of case studies; and
- assessment of potential savings through instruments of sustainable chemistry.

Moreover, within the context of the project, the internationally oriented Conference "Sustainable Chemistry 2015: the way forward" was convened in September 2015. The concept of sustainable chemistry was presented here. The issues of where sustainable chemistry stands at present, and which steps should be taken next were jointly worked on. Important reference points in this work undertaken were the United Nations’ Sustainable Development Goals and the International Sustainable Chemistry Collaborative Centre ISC3 which is to be set up soon.

The results of the project have been depicted in detail in the chapters 1to 9 of the long version of the final report, which is available in German in addition to the short version. This short version sets the focus on the following aspects:

- How can sustainability in chemistry be measured? The indicator set “Parameters of Sustainable Chemistry” and the map of Sustainable Chemistry.

In April 2016, a first version of the Concept of Sustainable Chemistry has been prepared. At present, this draft is further developed within the work to establish the International Collaborative Center for Sustainable Chemistry (ISC3). The publication of the Concept of Sustainable Chemistry has been published in Spring 2017. After the publication the concept can be received from the Federal Environment Agency (contact: Christopher Blum, email address: Christopher.blum@uba.de).

2 How can sustainability in chemistry be measured? The indicator set and the map of Sustainable Chemistry

2.1 Conceptual formulation and outcome

In order to be able to evaluate sustainability, quantifiable indicators are an important tool. Hence, such indicators have been elaborated in the scope of this project. They enable the assessment of specific sustainability measures applied in enterprises. The target group for the application of these indicators is enterprises which produce or use chemicals. Together, the indicators form a set of indicators.

The set of 25 quantifiable indicators on sustainability is supplemented by the „Map of Sustainable Chemistry“. This map shows which areas of Sustainable Chemistry have been addressed by a measure.

On the basis of a detailed literature review and in accordance with quantifiable criteria sets for sustainability, the development of the indicator set “Parameters of Sustainable Chemistry” was organized in a multi-stage process permitting the application in the chemical industry.

In light of the European and international sustainability debate (Rio+20 and Sustainable Development Goals (SDGs)), an approach as inclusive as possible has been chosen, including, beyond purely resource efficiency-related aspects, economic and social parameters.

The indicator set “Parameters of Sustainable Chemistry” covers all major topics pertaining to Sustainable Chemistry. It is based on six core criteria. Seventy-eight indicators were initially selected. In order to ensure good applicability in enterprises, they were condensed into 25 indicators as demonstrated in the following figure. Please refer to chapter 6.1 of the long version of the final report for details

Tabelle 1: The indicator set “Parameters of Sustainable Chemistry“ (25 indicators)

KK		Indicator[1]	Target unit[2] (if necessary, adaptable to a specific application)
1	NC 1	GHG emissions	kg CO_2 equivalents over life cycle (ideally, GWP_{100} according to LCA)
2	NC 2	Raw material consumption	kg; can also be expressed in terms of loss potential(WP_{KRA}) according to LCA
2	NC 3	Raw material intensity/ productivity	kg raw material/kg product or kg product/kg raw material
2	NC 4	Percentage of renewable raw materials for material use	% of total raw material input
2	NC 5	Energy expenditure	kWh or MJ (taking into account all energy resources, i.e. renewable and non-renewable ones (upper calorific value) can also be expressed in terms of loss potential (WP_{KEA}) according to LCA
2	NC 6	Energy intensity/productivity	kWh/kg product or kg product/kWh
2	NC 7	Total water requirements	m^3 / also conceivable as water scarcity potential (WVP m^2 H_2Oe) according to LCA
2	NC 8	Percentage of recovered water	% of total water consumption
2	NC 9	Pollutant emissions into the air	amount/year (e.g. µg/a or µg/kg product), can also be expressed in terms the sum indicator “acidification potential” (kg SO_2 equivalents) and toxic injury caused by fine dust (AFP) kg PM10 equ. according to LCA
2	NC 10	Pollutant emissions into water and into soil	amount/year (e.g. µg/a or µg/kg product), can also be expressed in terms of the sum indicator „aquatic and terrestrial eutrophication potential” (EP) (kg PO43-e) according LCA
2	NC 11	Waste volume	t/a or t product

1 Direct + indirect effects of sustainability tools

2 If possible, per t of product mass, alternatively per annum, for example

KK		Indicator[1]	Target unit[2] (if necessary, adaptable to a specific application)
2	NC 12	Percentage of hazardous waste	% of waste emissions
3	NC 13	Sustainability information on production	% of product mass
3	NC 14	Percentage of hazardous substances (as indicator for substitution of hazardous substances)	% in product mass and classification according to CLP and further hazardous characteristics (such as PBT, endocrine disruption); calculation of environmental hazard and health hazard potential (such as Freshwater Toxicity (CF); Human Toxicity Potential (HTP_{cancer}, $HTP_{non\text{-}cancer}$; or hazardous substances potential (HSP)[3])
4	NC 15	Work-related accidents	total/year
4	NC 16	Occupational diseases	% of persons employed
5	NC 17	Economic benefits through sustainable action	€/year
5	NC 18	Intensity of capital expenditure to protect the environment and/or resources	% of total investment and € per year
5	NC 19	Market presence	Market share in % (sales enterprises divided by sales market)
5	NC 20	Share of suppliers and contractors audited for their compliance with human rights and environmental aspects	% of all suppliers and contractors (along the entire value chain)
6	NC 21	Certification according to ISO, EMAS etc.	List of certifications
6	NC 22	Staff training and education	h/employee/year (related to the spatial system boundary)
6	NC 23	Total percentage of women	% of persons employed (related to the spatial system boundary)
6	NC24	Total percentage of women in managerial positions	% of employees in managerial positions (related to the spatial system boundary)
6	NC 25	Persons with contracts of work	% of persons employed (related to the spatial system boundary)
-	-	Other benefits	Non-quantifiable

[3] The hazardous substances potential (HSP) is calculated from the "impact potential" of hazardous substances and the level of pollution in the product, applying the indicator "monoethylene glycol equivalents (MEG equ.)" (Bunke and Graulich 2003). The determination of the hazardous substances potential comprises three steps: determination of the impact factor W for the hazardous substance (on the basis of R phrases using an allocation table according to TRGS 440); comparison of the substance with the reference substance (monoethylene glycol); accounting of the quantities actually used. An adaptation of the new H phrases under CLP is planned.

2.2 Objectives, User Groups, Limitations

2.2.1 The aim of the indicator set

The indicators should provide an initial assessment as to what extent companies dealing with chemicals have already implemented sustainability aspects, and reveal the existence of need for action. The indicators particularly address the level of the individual enterprise. They do not primarily have the objective of reflecting the trends prevailing in an entire industry branch.

An investigation using the indicator set can be applied to six different areas:

- products (substances, preparations, materials, articles)
- processes and services
- other activities (such as trade in chemicals and chemical products)
- single site of an individual company or the entire company

2.2.2 User groups and results

The evaluation will focus on companies which work with chemicals, be it in production, processing or trade. Companies can undertake different evaluations by using the set of indicators:

- The company takes measures that have positive implications on sustainability aspects. On the basis of the indicator set, companies can determine the current level before and after implementation of the action. Thereby, it depends on the nature of the action investigated which indicators are of importance and where modifications are not necessary. For example, some of the indicators primarily relate to the company as a whole (e.g. certification and the proportion of women). These indicators will remain generally unchanged in the event that measures relating to a specific product are taken.

Alongside the comparison of the situation before and after an action has been put in place, the indicators also facilitate a monitoring of the status quo.

The result is a first quantitative assessment as to where the company stands in the field of sustainability, or whether a specific measure has led to greater sustainability. This assessment provides guidance to the company on the direction to take, relying on data that can be collected in the company itself.

2.2.3 Application Boundaries of the indicator set

The more similar the boundary conditions of the examination are the easier is a comparison of several possibilities (before / after the implementation of a measure). If, for example, in the event of a change in process temperature, the energy sources used remain the same. A comparison becomes increasingly difficult when there are diverse boundary conditions. Then, a detailed description of benchmarks and process parameters is required. This also means taking into account the origin of the materials used and their up- and downstream chains. Therefore, a comparison will presumably be easier if it is made within a company. It becomes more complicated, if activities of different companies are to be compared.

As a basis for action to be taken and thus an implicit precondition for the application of the indicator set, the implementation of existing provisions in the chemicals sector, such as REACH and IED, provides a major contribution to the achievement of the sustainability objectives. This implementation should be monitored autonomously by companies which should furthermore report about it in their sustainability reporting. Since the indicator set addresses individual actions directly related to substances, materials and products, it does not contain any indicators required to fulfill the statutory requirements. For this purpose, companies should apply complementary indicators.

The indicator set does not provide any individual evaluations in detail. This would require the coverage of the materials' up- and downstream chains. There are other appropriate instruments (LCA, product carbon footprints, OEF and others) for these more extended and detailed investigations. However, the values derived on the basis of the indicators (e.g. relating to energy expenditure) can be used for such follow-up reviews. Hence, the current state of the method discussion on other assessment tools (in particular LCA) was taken into account in developing the indicators.

2.2.4 The Indicator Set and the United Nations' Sustainable Development Goals

In September 2015, 17 Sustainable Development Goals (UN SDGs) have been agreed upon by the UN. They have been specified by sub-targets. The indicators of sustainable chemistry developed in the scope of the project can be used to concretize several of the sustainability objectives set out by the United Nations at a business level.

In the first column, the following table shows how the indicators of the indicator set "Parameters of sustainable chemistry" can be allocated to the sub-targets of the Sustainable Development Goals. In this allocation, no direct comparison has been made between the indicators of the indicator set "Parameters of sustainable chemistry" and the indicators of the United Nations' Sustainability Goals. These indicator systems focus on different things.

- The indicator set "Parameters of sustainable chemistry" particularly addresses the application by companies – with the aim of assessing individual measures.
- The United Nations' indicators relating to its Sustainability Goals are oriented towards other aspects. They have been designed to document the success of a specific measure such as the share of the population with access to clean drinking water. They address the international level.

To address these different levels, different tools are required. In this respect, the indicators systems complement each other, even if the individual indicators are not directly comparable. The following table thus shows the allocation of the indicators to the individual sub-targets, by which the United Nations have specified their Sustainability Goals.

Tabelle 2: Sustainable Development Goals (SDGs), which are relevant for sustainable chemistry, and allocation of the indicators oft he indicator set „Parameter of Sustainable chemistry"

KK		Indicator[4]	SDG target
1	NC 1	GHG emissions	
2	NC 2	Raw material consumption	12.2
2	NC 3	Raw material intensity / productivity	11b, 12.2
2	NC 4	Percentage of renewable raw materials for material use	11b, 12.2, 12.5
2	NC 5	Energy expenditure	12.2
2	NC 6	Energy intensity/productivity	11b, 12.2
2	NC 7	Total water requirements	(6.3), 6b, 12.2
2	NC 8	Percentage of recovered water	6.3, 6b
2	NC 9	Pollutant emissions into the air	3.9, 12.4
2	NC 10	Pollutant emissions into water	3.9, 6.1, 6.3, 6b, 14.1, 12.4
2	NC 11	Waste volume	14.1, 12.4, 12.5, 13
2	NC 12	Percentage of hazardous waste	3d, 3.9, 14.1, 12.4
3	NC 13	Sustainability information on production	12.1, 13
3	NC 14	Percentage of hazardous substances	3.9, 3d, 12.1, 12.4
4	NC 15	Work-related accidents	
4	NC 16	Occupational diseases	3.9, 12.4
5	NC 17	Economic benefits from sustainable measures	
5	NC 18	Intensity of capital expenditure to protect the environment and/or resources	12.6
5	NC 19	Market presence	
5	NC 20	Share of suppliers and contractors audited for their compliance with human rights and environmental aspects	3d, 6b, (12.4), 12.6, 4.4, 4.7
6	NC 21	Certification according to ISO, EMAS etc.	(12.4), 12.6
6	NC 22	Staff training and education	3d, 6b, 4.4, 4.7
6	NC 23	Total percentage of women Anteil	5.1, (5.5)
6	NC 24	Percentage of women in executive positions	5.1, (5.5)
6	NC 25	Individuals covered by a working agreement	5.1, (5.5)

More information about the connection between the UN SDGs and the indicator set "Parameters of sustainable chemistry" are disclosed in Chapter 3.3 of the long version of the final report. The application of the indicators and possible ways of assessing the emission reduction potentials through instruments of sustainable chemistry are set out in the Chapters 4 – 7 of the long version of the final report.

4 Direct + indirect effects of the sustainability tool

2.3 The Map of Sustainable Chemistry

The set of 25 quantifiable indicators on sustainability is supplemented by the "Map of Sustainable Chemistry". This map shows which areas of sustainable chemistry have been addressed by a measure. Reference points of the map are the following six core criteria for sustainable chemistry as set out in the project:

1. Minimization of the climate footprint of products and production processes;
2. minimization of negative **impacts on the environment** as well as on energy and resources of chemicals used in production and application processes;
3. optimization of **product design**, taking account of the whole life cycle, by means of technical innovation, knowledge transfer and optimized integration of environmental, economic and social aspects in operational processes;
4. minimization of **risks to health** arising from substances, production and products;
5. provision of **economic benefits** through environmental investments and sustainable cooperation;
6. optimized integration of **environmental, economic and social aspects** in operational processes in terms of transparency, training, social standards, dialogue and international cooperation.

The six thematic fields shown on the map result therefrom.

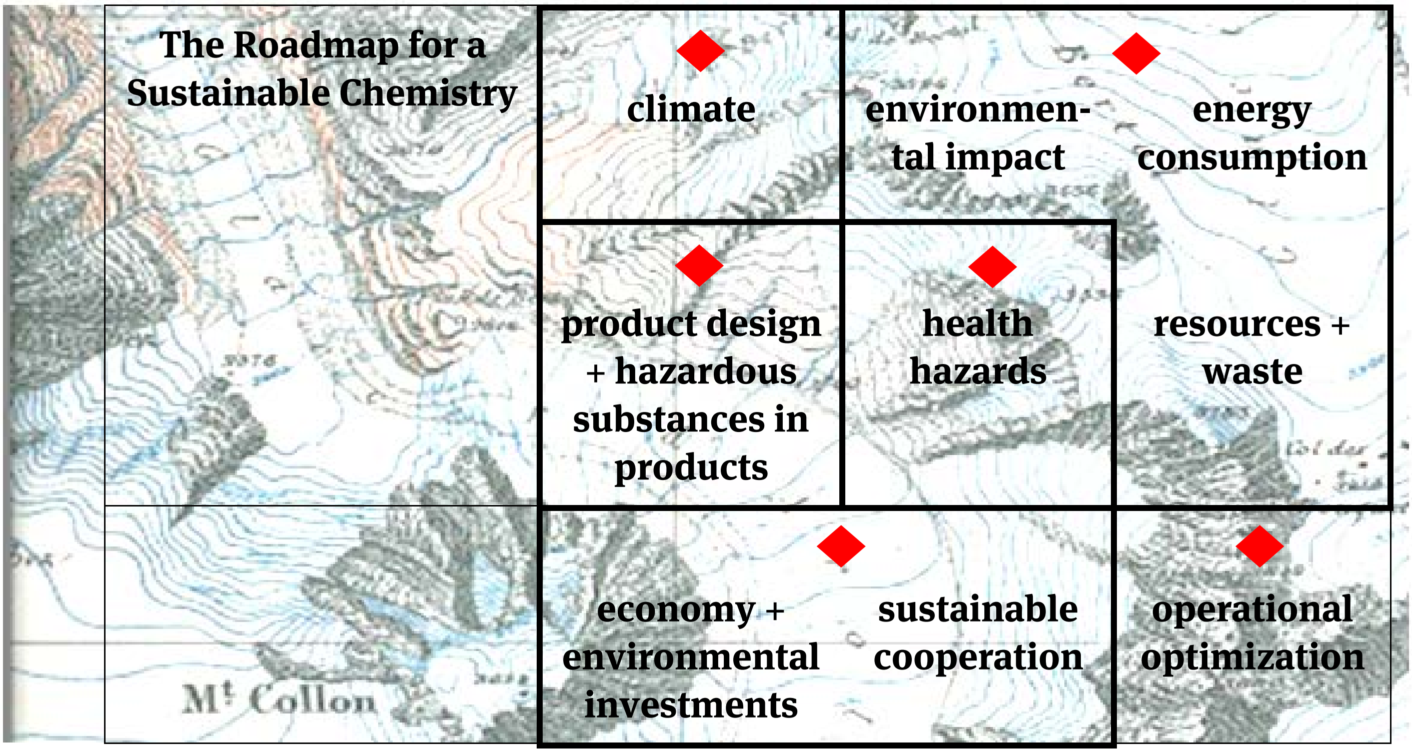

Figure 1: The map of sustainable chemistry. The six fields refer to the six core criteria which have been used to group individual sustainability indicators.

The map for sustainable chemistry and its application are set out in detail in Chapter 3.4 of the long version of the final report.

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