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Evaluation of the Possibilities of a Stronger Involvement of the Chemicals Sector in a Green Economy

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Evaluation of the Possibilities of a Stronger Involvement of the Chemicals Sector in a Green Economy

by

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Abstract

Green Economy (GE) is an important element for a global sustainable development, as it supports all three dimensions of sustainability - economic, social, and environmental and contributes to its further development. Therefore, it is an essential goal for national, regional, and international activities and initiatives to implement GE in all economic sectors.

The chemicals industry has a particular importance in the process of transformation into a GE as it is resource- and energy-intensive, and deals with various and sometimes highly hazardous substances. On the other hand it shows high potentials for innovation and delivers essential materials and products that are necessary for a sustainable development. Thus, a stronger involvement of the chemicals sector in a GE could enhance all dimensions of sustainability.

This project examines the contributions of the chemicals sector to a GE. For this purpose, it analyses existing national, European, and international legislations, programmes and voluntary initiatives in the topic areas of environment and health (E&H), chemical safety (CS), and sustainable chemistry (SC) and their contribution to a GE.

By means of an analysis of the definitions of GE, CS, SC, and E&H, it develops a set of GE criteria, which is used subsequently to analyse the political initiatives and industrial activities regarding their contribution to a GE. Furthermore, the deficits of the chemicals sector with respect to the GE criteria are discussed although the success of implementation could not be investigated.

Finally, based on the identified results, the project provides recommendations and options of action to policy makers on the contributions of the chemicals sector for the international GE discussion.

In doing this, on the one hand, concrete proposals are introduced, on how specific contributions of the chemicals sector could be integrated into the GE discussion processes. On the other hand, concrete measures are suggested on how GE could be realised in the topic areas of CS, E&H and SC in order to eliminate existing deficits. Thus, the proposals shall help to better integrate the chemicals sector into a GE.

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Executive Summary

Background and Objectives

Considering the visual impacts of unlimited economic growth, a global sustainability strategy was developed in the early 1990s, which resulted in the concept of a Green Economy (GE). In 2012, the United Nations (UN) adopted a global strategy for GE at the summit in Rio de Janeiro [UN 2011]. The GE is considered an important element of sustainable development, which supports the environmental, social, and economic dimensions of sustainability and contributes to poverty alleviation [BPA 2012]. Due to its broad variety of products, the use of potentially hazardous substances and the high demand for resources, the chemical sector is considered of high significance for realising a GE in Germany (see chapter 1.1).

The overarching objective of this research project was therefore to identify and discuss the possibilities of a stronger integration of the chemicals sector into the GE. For this purpose, important definitions of GE, environment and health (E&H), chemical safety (CS), and sustainable chemistry (SC) were analysed and compared and a set of GE criteria was developed taking into consideration the needs of the chemicals and environment and health sector.

In order to identify how far the three topic areas contribute already to the objectives of a GE and to analyse which potential for improvement is inherent in examples of good practice, a comprehensive literature review of current legal, political, and voluntary initiatives as well as literature and project approaches on the three aforementioned topic areas was conducted in addition. These initiatives and approaches were analysed regarding their contribution to the developed GE criteria, and proposals were elaborated on this basis on how experiences and successes from the three topic areas can be used to enhance the GE and which measures are necessary to establish a GE in the three topic areas (see chapter 2).

Results

Similarities and Differences among the Definitions

The investigated definitions of GE (see chapter 3.1), SC (see chapter 3.2), CS (see chapter 3.3), and E&H (see chapter 3.4) are comparable in many aspects, especially concerning the reduction of environmental and health risks and, resource efficiency and decent working conditions. On the contrary, other criteria, such as the increased use of renewable raw materials, reuse and recycling, innovations, biodiversity, and ecosystem services, as well as social and economic criteria are only explicitly mentioned in a few

definitions (see chapter 3.5).

Political Activities in the Topic Area of Environment and Health

For the topic area of E&H, key activities identified were the *WHO Global Strategy on Public Health and Environment PHE* (see chapter 4.1.1) the *European Environment and Health Process EHP* (see chapter 4.1.2) and the German *Action Programme Environment and Health APUG)* (see chapter 4.1.3). In addition, the *European Environmental Action Programme (EAP)*, the *Framework Programmes for Research and Technological Development (FP)*, the *EU LIFE Programme LIFE+,* and the European health programmes contain E&H aspects. On the national level, the *Environmental Research Plan (UFOPLAN)* as well as the socio-economic part of the *German Framework Programme Research for Sustainable Development (FONA)* were identified as E&H initiatives. The United States' *National Health and Nutrition Examination Survey (NHANES)* [CDC 2014] or *National Environmental Health Action Plans (NEHAPs)* of several EU member states represent examples of good practice for single E&H aspects (see chapter 4.1.4).

Political Activities in the Topic Area of Chemical Safety

The most important international instruments regarding safe chemicals policy are the *Strategic Approach to International Chemicals Management* (*SAICM)* with the *Globally Harmonised System (GHS)* and the international conventions on chemicals management, such as the *Rotterdam Convention*, the *Stockholm Convention*, and the *Minamata Convention* (see chapter 4.2). Furthermore, WHO's *International Programme on Chemical Safety (IPCS)* and the UNEP activities *Flexible Framework Programme, Responsible Production* and *Awareness and Preparedness for Emergencies at Local Level (APELL)* are worth mentioning in this context. Another important programme is the *Environment, Health and Safety (EHS)* programme of the Organisation for Economic Co-operation and Development (OECD), harmonising the used methods and conducting common risk assessment (see chapter 4.2.1).

On the European level, the *European Chemicals Regulation (EC) No 1907/2006 (REACH)* and the *CLP Regulation (EC) No 1272/2008* on c*lassification, labelling and packaging of substances and mixtures*, in particular, have to be emphasised as they combine all aspects of a safe (and sustainable) chemicals management. In addition, the *PIC Regulation (EC) No 649/2012* and *POP Regulation (EC) No 850/2004* regulate important parts of the chemicals management. On the national level, the *Chemicals Act (ChemG)* and the *German Ordinance on Hazardous Substances (GefStoffV)*, in particular, constitute important directives (see chapter 4.2.2).

Concerning the chemicals legislation on specific groups of

substances, the European *plant protection products regulation (EC) No 1107/2009*, the *EU Fertilisers Regulation (EC) No 2003/2003,* the *Regulation (EU) No 528/2012* on biocidal products, as well as the *Detergents Regulation (EC) No 648/2004* and the *Regulation (EC) No 726/2004* on pharmaceuticals, in particular, shall be underlined as important regulatory instruments that may serve as a role model for international discussions. The corresponding national regulations contain requirements sometimes exceeding those of the European regulations (see chapter 4.2.7).

Moreover, regulations on waste and hazard management (see chapter 4.2.6), on water protection (see chapter 4.2.5) as well as on occupational health and safety (see chapter 4.2.3) contribute significantly to the safe handling of chemicals.

The *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*, the *Seveso Directive 96/82/EC, regulation (EC) 1013/2006 on shipments of waste, the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE),* and the *Ordinance on the restriction of the use of certain hazardous substances in electrical and electronic equipment (ElektroStoffV)* are especially worth emphasising.

Regarding the protection of water bodies, the *Water Convention* of the United Nations Economic Commission for Europe (UNECE), the *Water Framework Directive 2000/60/EC* (see chapter 4.2.5), the *Directive 2010/75/EU on industrial emissions (IED),* and the *Federal Water Act (WHG)* were identified as important approaches (see chapter 4.2.5).

Important contributors to occupational health and safety are the action plans and programmes of the WHO and the International Labor Organization (ILO) as well as the *European Framework Directive on Safety and Health at Work (Directive 89/391 EEC)* with the associated *Directive 98/24/EC on the protection of the health and safety of* workers *(CAD)* and *Directive 2004/37/EC* on carcinogens and mutagens *(CMD)* or the *Occupational Safety and Health Act (ArbSchG)*, the *ChemG,* and the *GefStoffV.*

Political Initiatives in the Topic Area of Sustainable Chemistry

The most important activities in the topic area of SC are similar to those of CS: *REACH* and *SAICM*, the *Stockholm Convention*, the *Rotterdam Convention*, the *Basel Convention,* and the *EHS*. Furthermore, the *WEEE Directive* and the regulations on pesticides, biocides, and fertilizers as well as the *RoHS* contain essential information on SC (see chapter 4.3.2). The *Montreal Protocol* and the *Kyoto Protocol*, the *Regulation on Ozone depleting substances (EC) No 1005/2009 (ODS)*, the *Directive 2004/42/EC on the limitation of emissions of volatile organic compounds (VOCs)*, the *Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases (F-Gas Regulation)*, and the *IED* were identified as key regulations.

In addition, non-binding initiatives contribute to the implementation of *SAICM*, such as *Chemical Leasing (ChL)* of the United Nations Industrial Development Organisation (UNIDO) and the OECD network on SC *(SCN)* (see chapter 4.3.1). For Germany, the *Chemicals-Climate Protection Ordinance (ChemKlimaschutzV)* and the *Ozone Layer Chemicals Ordinance (Chem-OzonSchichtV)* were considered in addition to the regulations in the topic area of CS. Moreover, we identified a couple of approaches that are specifically important in the context of SC. The *Workshop on Sustainable Chemistry* by the German Federal Environment Agency (UBA) and OECD, the *Guide on Sustainable Chemicals*, pilot projects on *ChL*, a *research project on strategies for CS and further development SC (Assistenz bei der Evaluierung von Strategien zur Chemikaliensicherheit und Weiterentwicklung einer Nachhaltigen Chemie in Deutschland*) or publications like *Going Green: Chemie* (see chapter 4.3.3).

Political Initiatives in the Topic Area of Sustainability and Resource Efficiency

Besides the chemical specific initiatives also more general sustainability initiatives were considered for the identification of SC contributions to a GE. On the international level, in particular the *Agenda 21,* the UNEP programme *Resource Efficient and Cleaner Production (RECP)*, and the *ISO Standard 14001* were assessed (see chapter 4.3.4).

On the European level, the sustainability strategy *EU 2020* with the

associated *Roadmap to a Resource Efficient Europe* and the *Sustainability Action Plan* are the central control elements (see chapter 4.3.5). Compared to the international level activities, in particular the concrete targets on jobs, research and development (R&D), greenhouse gas (GHG) emissions, renewable energies, energy efficiency, education, poverty and social exclusion, strengthened requirements for Green Public Procurement (GPP), and the efforts on environmental footprinting, have to be emphasised. Good practice examples of the sustainability strategy include the *EMAS II Regulation (EC) 1221/2009*, the *emissions trading system (EU ETS)*, the *Ecodesign Directive 2009/125/EC*, and the EU *Ecolabel regulation (EC) 66/2010*.

On the national level, the *National Sustainability Strategy*, the *High-Tech Strategy,* and the *Programme for Resource Efficiency (ProgRess)* were specifically considered. With respect to these approaches, the *German Sustainability Code (DNK)*, the establishment of *efficiency agencies* and expert panels, networks, funding programmes and awards as well as the facilitation of safe and sustainable chemicals management in developing and emerging countries are worth mentioning. This is also true for the communication on sustainability (see chapter 4.3.6).

As further examples of good practice, the *Pollution Prevention Strategy (P2)* (see chapter 4.2.4)*,* the *Chemistry Innovation Transfer Network* (see chapter 5.3), the *Green Chemistry Resource Exchange (Green ChemEx)* (see chapter 5.6), and the *Presidential Green Chemistry Challenge Awards* (see chapter 5.6) were identified.

Voluntary Initiatives of the Three Topic Areas

The cooperation of the German Chemical Industry Association (VCI) and the BMUB on the *Prioritisation of Substances for Human Biomonitoring* and the global *Long-Range Research Initiative (LRI)* of the International Council of Chemical Associations (ICCA) were identified as important voluntary approaches (research projects, management approaches, tools on chemistry developed by industry, science and non-governmental organisations) of the E&H topic area (see chapter 5.1). Within the topic area of CS, the *Global Product Strategy (GPS)* and ICCA's *Responsible Care* were selected as particularly significant approaches. Concerning special substances, the initiative on respirable crystalline silica of the European Network on Silica (NEPSI) and the *Voluntary Emission Control Action Program (VECAP*) on brominated flame retardants were considered (see chapter 5.2).

For the topic area of SC, *Responsible Care,* the *European Technology Platform for Sustainable Chemistry (SusChem),* and the national initiative *Chemie hoch 3* were identified as important approaches. As systems of incentives the *European Sustainable Chemistry Award* and the *Global Chemical Leasing Award* were considered (see chapter 5.3). Furthermore, general sustainability initiatives such as the *Global Product Stewardship (PSC*) (see chapter 5.5) and the *Global Reporting Initiative (GRI)* (see chapter 5.5) are evaluated under SC. Moreover, a variety of good practice examples could also be identified for the topic area of SC although they are not specifically included in the assessment of the GE criteria fulfilment (see chapter 5.6).

Sustainability Initiatives of the Financial Sector

Within the financial sector, the World Bank initiative *Inclusive Green Growth: The Pathway to Sustainable Development* and the

Workshop of the International Monetary Fund (IMF) in cooperation with UNEP, which supports the development of tax measures for a GE (see chapter 5.7.1), were identified. On the national level, the approaches of the *Credit Institute for Reconstruction (KfW)* and the *Association for Environmental Management and Sustainability in Finance* Institutes e.V. (VFU), in particular, have to be mentioned. *DOW Jones Sustainability Index (DJSI), Calvert Social Index* and *FTSE4 Good Environmental Leaders Europe 40* (see chapter 5.7.1) as indices of sustainability, *Eurosif* and the *Forum for Sustainable Investment (FNG)* as a financial association (see chapter 5.7.2) or Robeco SAM as an investment company for sustainable projects are worth mentioning (see chapter 5.7.1).

Discussions on Green Economy

The essential international discussions on the implementation of *Rio+20* are the *Green Economy Initiative (GEI)* (see chapter 4.4.1), UNIDO's *Green Industry Initiative (GII)* and the strategy towards *Green Growth (GG)* of the OECD (see chapter 4.4.1). The focus of these activities is the development of indicators and strategies for the recording of progress and for the identification of possibilities or problems. On the European level, mainly the discussions within *Europe 2020* are to be mentioned, whereas in Germany, the main discussions are in the context of the *Agenda Process GE* and *SusChem*.

Achievements of the Chemical Industry with Respect to the Fulfilment of Green Economy Criteria

The review of the most important political and voluntary activities in the topic areas of E&H, SC, and CS shows that during the last years and decades, a lot of progress has been made in the chemical sector regarding sustainability and the transformation to a GE. This is true for both political and the voluntary activities. National and European initiatives were usually the decisive factor for international activities and ensured higher levels of protection, ambition, and commitment (see chapter 6.1).

The assessment of the analysed political approaches and voluntary initiatives suggests that several of the GE criteria are already considered and that their implementation is in progress. However, implementation does not mean that the objectives are met. This analysis was not possible within the frame of this study. The following paragraph summarises how GE criteria are included in political initiatives and what is to be expected from their implementation.

Summary Evaluation of the Fulfilment of Green Economy Criteria by Political Initiatives in All Topic Areas

In particular the criteria of emissions reduction, the demand for substitution of hazardous chemicals, the precautionary principle, the promotion of the quality of life, integrated decision-making, international cooperation, knowledge transfer, rule of law, as well as targeted legislation and its effective enforcement, are included as objectives in the analysed approaches of all three topic areas. This assessment is primarily based on *SAICM* with the *GHS*, the *Stockholm* and the *Rotterdam Convention,* as well as the *REACH*, *CLP*, the *PIC- and POP regulation,* the *IED*, and chemicals and product-specific legislations.

Furthermore, the positive assessment is affected by the *Montreal Protocol*, the *Kyoto Protocol,* and the *Minamata Convention* as well as by the European and German sustainability strategies, *BImSchG, PflSchG,* and *DüMG*, the German *High-Tech Strategy,* and *ProgRess*. The WHO's global *PHE strategy,* the *EHP*, the WHO's *IPCS*, the OECD *EHS,* or the *APUG* also cover the aforementioned broad spectrum of GE criteria (see chapter 6.1.1). For GE criteria such as intergenerational justice, protection of biodiversity, and fairness, it is expected that progress will occur due to the implementation of legal requirements.

Sustainable economic innovations are promoted explicitly by *SAICM*, *ChL*, *REACH*, *IED*, *EU 2020*, *F-Gas Regulation (EC) No 842/2006*, and the *EU ETS* (see chapter 4.2). Polluter pays principle is specifically anchored in several laws at European level. Important examples include *REACH*, the *IED*, the *European Framework Directive on Safety and Health at Work 89/391/EEC*, *WEEE Directive*, and the *EU ETS*.

Summary Evaluation of the Fulfilment of Green Economy Criteria by Political Initiatives within a Single Topic Area

Resource efficiency is a particular focus of *ChL, the Roadmap to a Resource Efficient Europe,* and the *Guide on Sustainable Chemicals*. The UNEP *RECP*, the European *SCP*, and the *High-Tech Strategy* are concerned with waste reduction, reuse, and recycling. The criterion product design is very well-covered by the eco-design directive. Legal regulations with restrictions and prohibitions contribute indirectly to the fulfilment of this criterion (see chapter 4.3). Increased use of renewable raw materials is mainly requested by the sustainability strategies on the European and national level. The GE criteria of workers' rights and of occupational health and safety are met, on the one hand, by *SAICM, Stockholm* and *Rotterdam Convention, REACH, PIC* and *POP regulation*, *IED* (see chapter 4.2.4), as well as by specific chemicals and products legislations. On the other hand, the WHO *Global Strategy for "Occupational Health for All"*, the *European Framework Directive on Safety and Health at Work* with its subsidiary directives, and the German *Occupational Safety and Health Act* with the *German Ordinance on Hazardous Substances* contribute to the criteria fulfilment.

Summary Evaluation of the Fulfilment of Green Economy Criteria by Voluntary Industrial Initiatives

Of the identified voluntary industrial initiatives, in particular the approaches of the topic area of CS and SC contribute to the fulfilment of GE criteria. Apart from the criteria rule of law, targeted legislation, and effective enforcement, which were, for systematic reasons, not considered relevant, the coverage of GE criteria by the different topic areas is, in our opinion, comparable

to those of the political initiatives.

In the topic area of SC, the major approaches are *SusChem, GPS, GlobalPSC,* the *GRI,* and the German sustainability initiative of the chemical industry *Chemie hoch 3.* They emphasise specifically the criterion of promoting sustainable economic innovations. The assessment of the topic area of CS is mainly based on *Responsible Care* and *GPS* (see chapter 6.1.2).

Weaknesses and Deficits with Respect to the Fulfilment of Green Economy Criteria by the Chemical Industry

The analysis of the political initiatives revealed a lack of suitable indicators on SC as well as cross-cutting deficits concerning the implementation of a proper circular economy (material recycling) and the stimulation of sustainable consumption (see chapter 6.2). Moreover, criteria explicitly mentioned as objectives may be accompanied by deficits and weaknesses regarding their actual implementation. Thus, a positive evaluation with respect to the GE criteria only implies that the legislative authority recognised risks and formulated ambitious targets, especially during the last years. In particular, international objectives are usually lacking in obligations, which consequently hinder their implementation (see chapter 6.2.3).

Proposals of Possible Contributions to the Green Economy Discussion

Overall, it is recommended to introduce the identified strengths and weaknesses (chapter 6.2) of the three topic areas into the discussion on future measures concerning GE and chemicals policy. As certain criteria are only a part of the German definition of GE, we recommend placing these aspects, especially the need of including the precautionary principle and of the durability of products as criteria, into the European and international discussions. In addition, there are a number of good examples of political and voluntary initiatives of the chemical and sustainability sector on the national level, especially in the topic areas of CS and SC, that exceed the European and global standards and could therefore be introduced to the discussions. Furthermore, the following specific proposals were elaborated in detail:

Proposal 1: Promotion of the Integration of Laws and Regulations for a Broader Coverage of Green Economy Criteria

In order to transfer the integrative approaches of *REACH* or *IED* to a GE, we suggest to the BMUB/UBA to work towards the implementation of the integration of laws and regulations on the European level in a first step. Harmonising the regulations is desirable in the long run on the national or European level (see chapter 7.1.1).

Proposal 2: Intensified Utilisation and Transfer of the Chemical Sector’s Established Mechanisms on the International Transfer of Knowledge for the Implementation of a Green Economy

To enhance the knowledge in developing and emerging countries and to accelerate the harmonisation of environment and health standards, we recommend to BMUB/UBA to transfer the principle of international information platforms on CS and SC to the generation of a platform for information and exchange of knowledge on GE in cooperation with the VCI. Furthermore, we recommend introducing experiences of the German industry to the development of the targeted activities and supporting international education programmes on SC and CS (see chapter 7.1.2).

Proposal 3: Transfer of Existing Communication Experiences for the Effective Implementation of a Green Economy

We recommend to the BMUB/UBA to introduce the special experiences of the chemical sector concerning advantages, disadvantages, and possibilities of the implementation of uniform reporting requirements along the supply chain into the ongoing discussion on the national, European, and international level. This should be achieved in cooperation with associations and enterprises of the chemical industry. An essential goal should be to better arrange the large number of information, which is already transmitted along the supply chain, according to the requirements of the target groups (see chapter 7.1.3).

Proposal 4: Transfer of Experiences Regarding the Advantages of International Conventions and their Interconnectedness to the Green Economy

The global harmonisation of standards (including global bans or restrictions of substances) with respect to a GE should be accelerated and international cooperation and transfer of knowledge should be facilitated. To achieve this, we propose to the BMUB/UBA to introduce the experiences made with synergies between conventions about chemical safety in the national and European discussions as an example for special contributions towards global fairness. On the other hand, we recommend to work towards the global adaptation of GHS requirements following European standards to achieve comparable standards in the medium- and long-term (see chapter 7.1.4).

Proposal 5: Upscaling of Selected Voluntary Sustainable Chemistry Initiatives Concerning Chemicals to Non-Chemical Products and Services

In order to reduce the workload for the legislative authority, to accelerate implementation, and to promote practical and economically beneficial solutions, we recommend to the policymakers and the

associations on the national, European, and international level to foster an increased and broader transfer and implementation of existing voluntary initiatives into the daily industrial practice. Furthermore, they should support other industrial sectors (manufacturing industry, commercial and financial industry) in adopting or learning from sustainability initiatives of the chemical industry (e.g. *Responsible Care*). This should be administered with the help of a close cooperation with other ministries and associations. We also recommend to companies and associations of the chemical industry to intensify the exchange with other sustainability initiatives on the national, European and international level and the cooperation among the involved partners and authorities and to fortify the development and utilisation of new user-oriented service models (see chapter 7.1.5).

Proposal 6: Promotion of Measures for the Prevention of Accidents as a Key Element of Humane Working Conditions and Human Rights

The prevention of accidents is an aspect of global fairness. In order to adjust it on a global scale to the European standards, we recommend strengthening the efforts for a global harmonisation of legal requirements, standards of enforcement, and safety at the workplace. For instance, the BMUB/UBA could, in cooperation with BMAS and BAuA, introduce the topic as a general objective into the GE discussion. On the other hand, we see considerable potential for the promotion of measures of accident prevention at the workplace by raising awareness, education, labelling, and adjustments of processes, especially on the global level. Here, the BMUB/UBA as well as associations and enterprises of the chemical industry can improve safety standards along the supply chain, and support international programmes by good practice examples or the provisions of experts (see chapter 7.1.6).

Proposals for Measures Needed to Establish a Green Economy in the Topic Areas of Environment and Health, Chemical Safety, and Sustainable Chemistry

Proposal 7: Strengthening of Obligations and Efficiency of International Initiatives on Sustainable Chemistry

The globalisation of production may go along with the distortion of competition and increased risks for environment and health due to low environmental, social, and health and safety standards in emerging and developing countries. To prevent this, we suggest to the BMUB/UBA to advocate the strengthening of *SAICM* obligations and its areas of influence and to promote the establishment of the respective structures for this development. One option would for example be to attribute convention status to *SAICM* (see chapter 8.1.1).

Proposal 8: Improvement of the Boundary Conditions for Substitution and Innovation

In order to increase the willingness to innovate, we suggest an improved communication concerning the economic benefits of innovations for a single company, provision of information and instruments for the determination of the resource demand, an enhanced knowledge about potential alternatives, financial incentives, and legal regulations (substitution based on relative performance levels). The established resource efficiency agencies could manage the information and communication aspects. In order to provide financial incentives in form of sustainability funding and information, we propose to the BMUB/UBA, in close collaboration with other ministries, the financial sector, and non-governmental organisations (NGOs), the enhancement of suitable criteria and evaluation systems for sustainable innovation as the essential supporting instrument. For legal measures, we propose a control of relative obligations of substitution such as the *regulation of plant protection products* (EC) No. 1107/2009 (see chapter 8.1.2).

Proposal 9: Upscaling of Sustainability Initiatives of the Chemical Sector to All Companies and Associated Production Chains

For a further greening of the chemical industry, it is important that associations and enterprises implement sustainability criteria and comparable standards and expand it to the products of the chemical industry. To achieve this, we recommend identifying feasible systems and criteria from the existing assessment, classification and reporting systems (see chapter 8.1.3).

Proposal 10: Development of Green Economy Indicators for the Chemical Industry for the Targeted Promotion of Innovation and Improved Evaluation of Sustainability

To eliminate uncertainties with regard to priority setting towards a sustainable chemistry and to simplify the evaluation of progress, we recommend an accelerated development of indicators for the chemical industry with respect to a GE. This should be elaborated in close cooperation between all political, industrial, and societal stakeholders (see chapter 8.1.4).

Each of the aforementioned proposals is individually valid and supports the achievement of the specific objectives. The proposals are designed to complement each other, and it is to be expected that the implementation of all recommendations will produce synergies and positive interactions.

1 Background and Objectives of the Project

1.1 Background

In 1970, the Club of Rome released its report ‘Limits to Growth.’ The study warns of the consequences of unlimited economic growth and focuses on global effects of industrialisation, population growth, malnutrition, destruction of habitats, and the depletion of resources. It underlines the limits to the earth’s growth and asks for the establishment of sustainable development [Meadows et al. 1972]. The World Summit in Johannesburg in 1992 founded the basis for a global sustainability strategy. This in turn led to the development of the concept of a Green Economy (GE). In 2012, the UN adopted a global strategy for a GE at the summit in Rio de Janeiro.

Although GE is not clearly defined, there are several definitions covering the basic elements of GE. The central idea is an ecologically friendly economy leading to sustainable development, which supports environmentally sound economic practices, equitable resource distribution as well as the protection of the climate system, the environment, and human health. These goals of sustainable economics are valid for all nations, developed and developing countries as well as countries in transition. The concept of a GE shall support the latter two in resource-saving, low-emission economic growth, and reducing poverty [BMZ 2011].

The concepts of GE and sustainability have large overlaps. Within their progress report concerning sustainability strategy [BPA 2012], the German Federal Government describes GE as an important element of sustainable development. It supports the environmental, social, and economic dimension of sustainability and contributes to poverty alleviation. Due to its broad variety of products, the use of potentially hazardous substances, and the high demand for resources, the chemical sector is of high significance for realising a GE. The following three topic areas are of major interest to the investigation of the integration of this particular industry into a GE: environment and health (E&H), chemical safety (CS), and sustainable chemistry (SC). Besides that there is no generally valid definition for the four terms, their prevalent definitions agree in their major issues; the topic area SC especially includes many criteria that are referred as important in a GE as well.

1.2 Objectives

The objective of the research project was to identify and discuss the possibility of a stronger integration of the chemical sector into the GE. Therefore, a literature review was conducted, which included current projects on the topic areas of E&H, CS, and SC

concerning GE. Subsequently, the extents of how much the three topic areas already contribute to a GE and of how these contributions can support the ongoing discussion on a GE were analysed. Furthermore, measures and options for action that can support the enhancement of a GE in the three topic areas were identified within this research project. Conclusions were drawn (see chapter 6), and recommendations are given (see chapters 7 and 8) on the basis of the previous analysis and with regard to the integration of the chemical industry into a GE. The proposals shall provide a basis for future measures in the national, European, and international chemicals policy and shall support decision-makers of this sector. In addition, the results of the analysis offer specific examples for discussions and processes of and towards a GE. They represent a basis for discussions in the international chemicals management.

2 Approach and Methods

In order to analyse examples from literature and practice, a comprehensive database was created, including the topic areas E&H, CS, and SC.

Popular definitions of GE, E&H, CS, and SC were identified and analysed with respect to the keywords used to express the most important contents. The usage frequency of these keywords was analysed, and the most commonly used keywords were condensed into a list of criteria for GE. The criteria helped to understand the relations and similarities between the three topic areas SC, CS, and E&H. In addition, they constituted a suitable basis for setting objectives and can be used for the GE discussion as well for the three topic areas themselves (see also chapter 3).

Afterwards, it was analysed whether and how far the activities and political initiatives identified in the topic areas SC, CS, and E&H could contribute to a GE (see Figure 2-1).

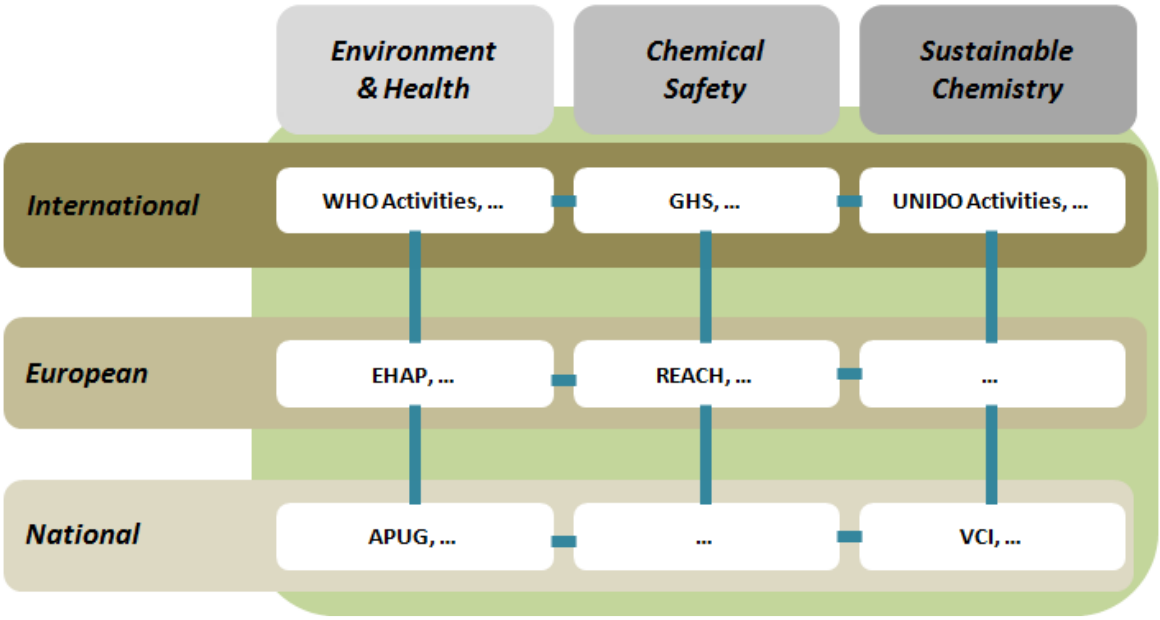

Figure 2-1: Exemplary overview on political measures and voluntary initiatives in the three topic areas

To this end the focus of every activity and initiative (political and voluntary) was described, and important discussions on GE on the national, European, and international level were illustrated, with no claim to be exhaustive.

Subsequently, each of the listed activities was compared to all identified GE criteria, and good contributions, deficits as well as non-relevant criteria were listed and quantified in an evaluation matrix. The evaluation was justified and – if available – backed up with references and short textual summaries.

Doing so, the political initiatives and legal approaches were separately investigated from voluntary approaches of the industrial sector.

The evaluation was based on the content of the activities and initiatives and not on the regional scope as they feature similar elements and are often closely linked between the international, European, and national levels.

Direct comparison of GE criteria and activities allowed a quick overview of the strengths and weaknesses of the three topic areas important to the chemical sector. This approach allowed identifying the following:

1. interfaces between the three topic areas and GE as well as the development of arguments for their involvement under the aegis of a GE
2. potential shortcomings of the topic areas concerning GE criteria

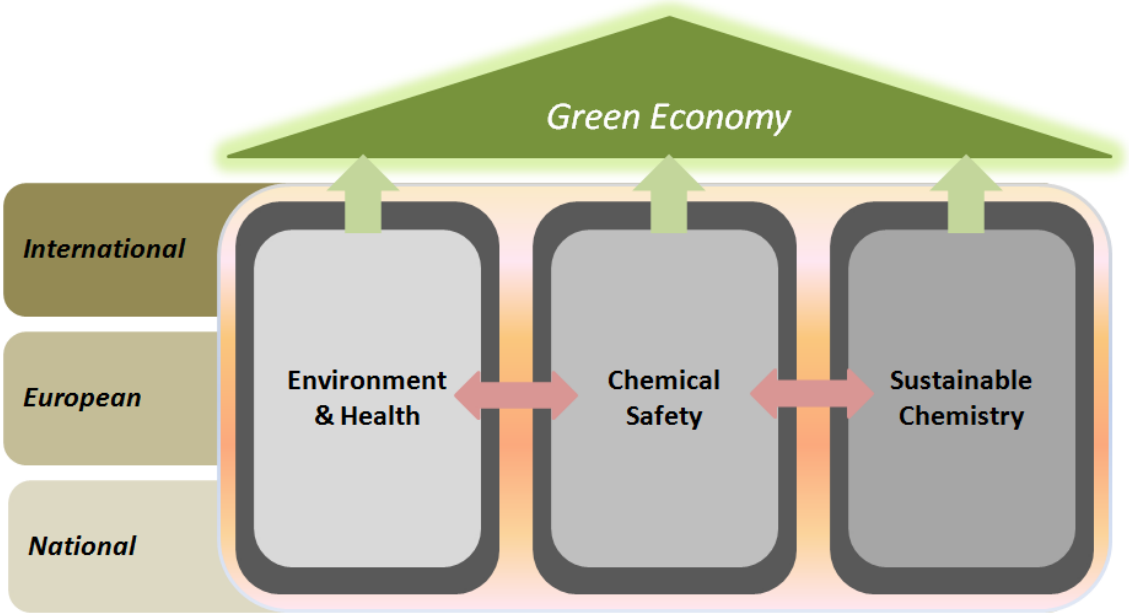

Figure 2-2: Schematic illustration of the relationship between topic areas, regional scope and GE as overarching concept

This comparative analysis and subsequent evaluation constituted the basis for the elaboration of proposals for a stronger integration of the topic areas E&H, CS, and SC into a GE. Specific recommendations for politics are given, which may also serve as a basis for recommendations to industry and enterprises.

The development of the proposals included two essential and complementary aspects of policy making:

1. Contribution of the topic areas of E&H, SC, and CS as options to action in national, European and international discussions regarding GE
2. Measures for the realisation of a GE in the three topic areas of E&H, SC and CS

It was the aim to highlight what has been reached in the chemical sector concerning GE already, and what chemical policy has achieved in the topic areas of E&H, SC and CS. On this basis it was pointed

out, which aspects of these topic areas would be suitable and necessary to enhance a GE (see chapter 6).

In addition, the project developed proposals on the basis of the evaluation for concrete improvements in the individual topic area, in order to optimally adapt them to the requirements and the criteria of the GE within the political possibilities (see chapter 8).

3 Essential Similarities and Differences among the Definitions of Green Economy, Environment and Health, Chemical Safety, and Sustainable Chemistry

3.1 Definitions of Green Economy

Several partly similar definitions of the term GE do exist. For this project, the definitions of the United Nations (UN), the European Environment Agency (EEA), the Federal Ministry of the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the German Federal Environment Agency (UBA) have been selected as the most relevant ones. Their relevance and focus depends on the respective political priorities.

United Nations Environment Programme (UNEP)

UNEP defines GE "as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient, and socially inclusive. In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services by aligning their investments with climate change adaption opportunities, and in doing so green the economy."[UNEPa]

Organisation for Economic Co-operation and Development (OECD)

The OECD describes green growth as follows: "Green growth means promoting economic growth while reducing pollution and greenhouse gas emissions, minimising waste and inefficient use of natural resources, and maintaining biodiversity. Green growth means improving health prospects for populations and strengthening energy security through less dependence on imported fossil fuels. It also means making investment in the environment a driver for economic growth." [OECD 2013a]

European Environment Agency (EEA)

"Fundamentally, a 'green economy' is one in which environmental, economic and social policies and innovations enable society to use resources efficiently, thereby enhancing human well-being in an inclusive manner, while maintaining the natural systems that sustain us." [EEA 2012]

European Commission

"The EU considers that an inclusive green economy is an essential mean of achieving sustainable development in the context of poverty eradication. A green economy can generate sustained growth, create green jobs and decent work and help eradicating poverty by promoting

investments and the preservation of the natural capital base upon which the long-term survival of our planet depends.” [DG DEVCO 2012]”

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) & Federal Environment Agency (UBA)

The federal agencies BMUB and UBA define GE as an innovation-oriented economy, which continuously reduces harmful emissions and pollutant inputs into all environmental media and is based on closed-cycle management and reuses waste as far as possible. Furthermore, it reduces resource consumption in absolute terms, protects the climate and strives for a long-term energy supply which is based entirely on renewable energy sources and generally seeks to act in harmony with nature and the environment, preserves biodiversity and restores natural habitats. [BMU & UBA 2011]

An additional description is given in the journal *Umwelt* (June 2012). Here, GE is said to be a concept that positively combines ecology with economy and thus increases social welfare.

3.2 Definitions of Sustainable Chemistry

Organisation for Economic Co-operation and Development (OECD)

“Sustainable chemistry encompasses the design, manufacture and use of efficient, effective, safe and more environmentally benign chemical products and processes. Within the broad framework of sustainable development, government, academia and industry should strive to maximise resource efficiency through activities such as energy and non-renewable resource conservation, risk minimisation, pollution prevention, minimisation of waste at all stages of a product life-cycle and the development of products that are durable and can be reused and recycled.

Sustainable chemistry is also a process that stimulates innovation across all sectors to design and discover new chemicals, production processes, and product stewardship practices that will provide increased performance and increased value while meeting the goals of protecting and enhancing human health and the environment.” [OECD 2013b]

Federal Environment Agency (UBA)

According to the UBA, “[the] concept of sustainable chemistry exists to link preventative protection of the environment and health with an innovative economic strategy that will also result in more jobs. Sustainable chemistry is a broad-ranging area that concerns stakeholders in the scientific community, the economy, public authorities, and environmental and consumer advocate associations.” [UBA 2012]

Regarding the approaches and objectives of a SC policy, UBA mentions the twelve principles of 'green chemistry' by Anastas und Warner [Anastas & Warner 1998] from 1998 and the twelve criteria for best available technique (BAT) in its appendix III of the *Directive 2010/75/EU on industrial emissions (IED)*[1]. According to the 2004 SC criteria that were jointly elaborated by UBA and OECD [UBA 2009a], the criteria for a SC are the following:

- qualitative development: Use of harmless substances, or where this is impossible, substances involving a low risk for humans and the environment, and manufacturing of long-life products in a resource-saving manner;
- quantitative development: Reduction of the consumption of natural resources, which should be renewable wherever possible, avoidance or minimization of emission or introduction of chemicals or pollutants into the environment. Such measures will help to save costs;
- comprehensive life cycle assessment: Analysis of raw material production, manufacture, processing, use and disposal of chemicals and discarded products in order to reduce the consumption of resources and energy and to avoid the use of dangerous substances;
- action instead of reaction: Avoidance, already at the stage of development and prior to marketing, of chemicals that endanger the environment and human health during their life cycle and make excessive use of the environment as a source or sink; reduction of damage costs and the associated economic risks for enterprises and remediation costs to be covered by the state;
- economic innovation: Sustainable chemicals, products and production methods produce confidence in industrial users, private consumers and customers from the public sector and thus, result in competitive advantages.

German Chemical Society (GDCh)

The general idea of sustainability is, according to the German Chemical Society (GDCh), a development of a society that meets the needs of the present without compromising the options of future generations. Economic, environmental, and social goals have to be regarded as equally important, and a holistic view on products and processes over the entire life cycle is an essential issue. SC

[1] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on on industrial emissions (integrated pollution prevention and control)

according to this definition means to search for a use and transformation of resources without damage to future generations. GDCh also mentions approaches for achieving this goal, e.g. catalytic processes in chemical production, energy and resource savings during processes, the use of biomass (without compromising the production of food) and material use of CO_2, research and development work on new energy sources through solutions that chemistry can provide for all areas of life (mobility, nutrition, clothing, living, etc.), contributions to all aspects of environment protection (pollution control in soil, water, and air), sustainable solutions along the entire life cycle and embedding the concept of sustainability into the education of students. [GDCh 2014]

European Technology Platform for Sustainable Chemistry (SusChem)

SusChem follows in its interpretation the approach of minimising the damage to the environment from processes and products, optimising the use of non-renewable resources and reducing emissions and waste. According to this interpretation, SC can increase the ecological efficiency on the individual and societal level. In particular, the interpretation underlines the protection and creation of new jobs, new expertise, and improved quality of life. *SusChem* considers SC as the basis for the innovations that a competitive, knowledge-based, enterprise-led economy in Europe needs. *SusChem* also underlines the high importance of social acceptance for solutions out of the SC [SusChem 2012].

3.3 Definitions of Chemical Safety

CS is usually not defined on its own but is used and described in a certain context by respective organisations.

Intergovernmental Forum on Chemical Safety (IFCS)

“Chemical safety is the prevention of adverse effects, both short- and long-term, to humans and the environment from the production, storage, transportation, use and disposal of chemicals.” [WHO 2014a]

World Health Organization (WHO)

“Chemical Safety is achieved by undertaking all activities involving chemicals in such a way as to ensure the safety of human health and the environment. It covers all chemicals, natural and manufactured, and the full range of exposure situations from the natural presence of chemicals in the environment to their extraction or synthesis, industrial production, transport use and disposal. […] Chemical safety has many scientific and technical components. Among these are toxicology, ecotoxicity and the process of chemical risk assessment which requires a detailed knowledge of exposure and of biological effects.” [WHO 2014b]

European Chemicals Agency (ECHA)

The European Chemicals Agency (ECHA) does not provide a concrete definition of CS but describes its major tasks as the following: „Implementation of European chemicals legislation in the interest of the environment and human health and in terms of innovation and competitiveness“. For this purpose ECHA is supporting „companies in complying with the legal requirements, advances the safe use of chemicals, provides information on chemicals and addresses chemicals of concern. [ECHA 2013]

3.4 Definitions of Environment and Health

World Health Organization (WHO)

“Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, and genetics” [WHO 2014c].

The 1989 *European Charter on Environment and Health* defines the following principles for public policy:

1. “Good health and wellbeing require a clean and harmonious environment in which physical, psychological, social and aesthetic factors are all given their due importance. The environment should be regarded as a resource for improving living conditions and increasing well-being.
2. The preferred approach should be to promote the principle of "prevention is better than cure."
3. The health of every individual, especially those in vulnerable and high-risk groups, must be protected. Special attention should be paid to disadvantaged groups.
4. Action on problems of the environment and health should be based on the best available scientific information.
5. New policies, technologies and developments should be introduced with prudence and not before appropriate prior assessment of the potential environmental and health impact. There should be a responsibility to show that they are not harmful to health or the environment.
6. The health of individuals and communities should take clear precedence over considerations of economy and trade.

7. All aspects of socioeconomic development that relate to the impact of the environment on health and wellbeing must be considered.
8. The entire flow of chemicals, materials, products and waste should be managed in such a way as to achieve optimal use of natural resources and to cause minimal contamination.
9. Governments, public authorities and private bodies should aim at both preventing and reducing adverse effects caused by potentially hazardous agents and degraded urban and rural environments.
10. Environmental standards need to be continually reviewed to take account of new knowledge about the environment and health and of the effects of future economic development. Where applicable such standards should be harmonized.
11. The principle should be applied whereby every public and private body that causes or may cause damage to the environment is made financially responsible (the polluter pays principle).
12. Criteria and procedures to quantify, monitor, and evaluate environmental and health damage should be further developed and implemented.
13. Trade and economic policies and development assistance programmes affecting the environment and health in foreign countries should comply with all the above principles. Export of environmental and health hazards should be avoided.
14. Development assistance should promote sustainable development and the safeguarding and improvement of human health as one of its integral components” [WHO EURO 1989].

3.5 Similarities and Major Differences between the Definitions

The following section summarises the most noticeable overlaps and discrepancies between the definitions of GE and the three introduced topic areas as this constitutes the basis for first clues for overarching criteria.

However, one has to be aware that the concept is based on different hierarchical levels because GE is a comprehensive concept whereas the other topic areas only refer to parts of economy and society. Hence, the degree of abstraction within the definition of GE is higher compared to those of the three topic areas, but this should not be considered as a drawback.

The comparison of the definitions shows a superimposition of the definitions of GE, SC, CS, and E&H concerning the reduction of risks for environment and health. The definitions of SC and CS

specifically refer to substitutions, emissions reduction, waste minimisation, and life cycle considerations.

Resource efficiency is explicitly mentioned in the definitions of GE, SC, and E&H, and the increased use of renewable resources is included in GE and SC.

Reuse or recycling is included in the definition of SC, which can be regarded as similar to the demand for a circular economy and the conservation of natural resources in the GE definition. Minimizing the exposure at work in the CS definition is a fundamental part of the call for decent working conditions in the GE definition.

Several social aspects, such as equality, poverty alleviation, employment, growth, biodiversity, and ecosystem services are mentioned in the definition of GE only on an international level and partly in the Environment and Health Charter. Specific criteria of E&H include the considerations of vulnerable and socially deprived groups as well as those of urban and regional planning, polluter pays principle, and global fairness.

Innovation is highlighted as a special element in the definitions of SC only on the international level.

It is of particular interest that criteria like closed material cycles and a special focus on renewable resources for GE, or criteria such as the precautionary principle, the longevity of products, environmental sinks, and competitive advantages are only mentioned as elements of SC in the German definition. This can be explained by the specific German economic and resource situation and the government’s priorities of economic policy. Moreover, this finding is suitable for a fundamental recommendation for the involvement of the German interests into the international discussions.

3.6 Interpretations of and Statements on Green Economy Priorities by Industrial Associations and Non-Governmental Organisations

3.6.1 German Chemical Industry Association (VCI)

In the context of the GE discussion the VCI’s point of view is that for the chemistry a resource approach that focuses on energy, water, air, and raw materials is most relevant. As discussed in their special report (07/2012) [VCI 2012a], an absolute reduction of resources seems hardly possible. Furthermore, innovative and resource-saving materials are prerequisites to satisfy the increasing need for prosperity and consumption in developing and emerging countries by protecting the environment at the same time. Resource efficiency should hence not end with the amount of consumed raw materials but should include the benefit of the products over

their entire life cycle. VCI also stresses that for the sustainability discussion and when setting political goals the consumption of raw materials is no valid indicator for the environmental footprint or pollution caused by a particular product (savings during use compared to usage for production). With reference to a study by the Institute for Energy and Environmental Research (IFEU) [Giegrich et al. 2012], they recommend that a variety of indicators should be taken in order to quantify various environmental impacts.

3.6.2 Federation of German Industries (BDI)

According to the BDI, GE refers to a global economy, which, by considering social effects, creates energy efficient, resource efficient, climate friendly, and environmentally sound growth. This can be achieved by innovations, intact value-added chains, and growth [BMBF & BMU 2012]. The BDI also states that the current sustainability strategy is lacking an adequate consideration in the interests of the industry. Thus, energy and climate politics have to be more in line with the market, and they have to be certain, competitive, and more sustainable [BDI 2014]. The coexistence of environmental product performance objectives (increase of energy efficiency, reduction of greenhouse gas (GHG) emissions, extension of renewable energies) and the lack of targets for service security and competitiveness, in particular, are strongly criticised. It is proposed that for environmental compatibility concerning energy to concentrate on the reduction of GHGs and to use the EU emissions trading as lead instrument. In addition, stronger international cooperation for the promotion of renewable energy shall prevent inefficiency [BUSINESSEUROPE 2013].

3.6.3 German Employers' Associations (BDA)

BDA raises the concern that, ‘one of the central challenges concerning ongoing competitiveness of Germany is that economic growth and ecological requirements have to be accommodated’. In the GE discussion the BDA misses that the environment industry is depending on products and in parts inevitably energy-intensive inputs from other branches: wind and solar energy cannot exist without the steal and chemical industry. Hence, the general ‘greening of the economy’ shall be put in focus. Policy is asked to ‘create the basis for the overall facilitation of innovations for nature conservation and efficient resource use in the economy through predictable, investment-friendly boundary conditions and a reliable energy policy without jeopardising the industrial basis’. According to the BDA, highly qualified employees in mathematics, informatics, natural sciences, and technology ‘STEM fields’ are a prerequisite in order to generate the necessary knowledge about

constant product and process innovations [BMBF & BMU 2012].

3.6.4 Association of German Chambers of Commerce and Industry (DIHK)

For the successful development of a GE, DIHK calls for an economic environmental policy that has to focus on the preservation of competitiveness. Investing into education and research is therefore a key issue because efficient use of energy and materials alone will not solve current problems. Open markets on both, a national and international level, are essential elements for more growth, welfare, employment, and protection of the environment also in developing countries. Thus, the aim would be a strengthening and the extension of German know-how with respect to the environment and globally a cost efficient environment and climate protection through knowledge and technology transfer [BMBF & BMU 2012].

3.6.5 German Confederation of Trade Unions (DGB)

The DGB and its trade unions consider the creation of jobs and the reduction of environmental burdens as positive effects arising from investments in energy and environment, which also improve the working and living conditions. This, however, requires a state to guide the investments correctly.

The trade unions underline the necessity of governmental regulations and the development of a GE in context to sustainable development. By provision of information and better qualification, employees shall be more involved into operational environmental protection [BMBF & BMU 2012]. Strengthening international structures for environment and sustainable development is regarded essential to prevent that the World Trade Organization (WTO) can enable higher profits due to proposals on Free Trade Agreements without social or environmental standards.

3.6.6 Greenpeace (GP)

GP is complaining about the fact that GE can be interpreted in various ways by different stakeholders and, like Germanwatch, asks for a fundamental transformation towards a green, fair, and just economy. Welfare, equality and intergenerational justice combined with the protection of the oceans, forests, climate, and resources are the key aspects for resource efficiency. On the other hand, nuclear energy, oil, coal, genetic engineering, toxic chemicals, and overexploitation of forests or oceans must not be part of GE. Governments are urged to:

- “Effectively regulate markets: Credible and consistent policy goals, legal frameworks and liability regimes are essential to steer societies from short-term profit maximisation to sustainable solutions.

- End harmful subsidies and make prices tell the truth: […] due to levies and regulation, prices of environmental and social “bads” reflect their true impacts on society, creating a level playing field for green solutions.
- Accept and define ecological limits: […] Governments need to define what global resources are available. On that basis, they need to agree to bring absolute consumption of renewable and non-renewable resources and the impacts of their extraction within planetary boundaries in a fair and equitable manner.

- […] protecting their citizens from toxic pollution, climate disasters […] and other environmental harms. This also includes securing their citizens' rights, including their rights to clean air, fresh water, a healthy environment, food and shelter, rich biodiversity, and jobs.
- Provide decent jobs and a just transition […] around the world.
- Abandoning GDP growth as an end goal per se and [include] societal and environmental goals with particular indicators […].
- […] making clear choices, phasing out unsustainable practices and creating long-term consistency
- Massively increasing the value given to the environment in political decision-making but avoiding simplistic monetising […].
- Assuring that new Sustainable Development Goals respect planetary boundaries to provide a visionary and credible framework for green economies. […] they must focus action on the next 5 to 10 years […].
- Establishing mandatory corporate accountability and liability rules […] but corporations can't just be volunteers.
- Strengthening sustainable development governance in all levels, including by upgrading the UN Environmental Programme into a specialised agency." [Kosonen & Mittler 2012]

3.6.7 Germanwatch

As Greenpeace, Germanwatch perceives the global, social, and societal dimensions in the sense of a Green AND Fair Economy, which considers ecological boundaries and human rights as the central element and recommends a three-dimensional approach of acting (leading the way – e.g. German energy transition), negotiating (about limits), and forming alliances (between progressive actors to strengthen the former two) [BMBF & BMU 2012].

3.6.8 German League for Nature, Animal Protection and Environment (DNR)

According to the DNR, a GE requires a vast transformation which has to include efficiency, sufficiency, and consistency. The GE has to be sustainable and enforced against old thinking and strong interests. The understanding of innovations is essential. It is not only about single technical or economic innovations, but about a fundamental process of modernisation in economy, policy, and society, which ranges from the education system over governmental institutions to a financial reform [BMBF & BMU 2012].

3.7 Expanded Green Economy Criteria Based on the Analysis of the Definitions

On the basis of a detailed analysis of common definitions of GE, SC, CS, and E&H and the subsequent evaluation of their keywords, the extended criteria for GE have been developed within the frame of this project, which are considered to summarise the main aspects of the definitions of the three topic areas. They are explained in more detail in appendix II of the German report.

Table 3-1: GE criteria from the evaluation of common definitions of GE, SC, CS, and E&H

Category	Criterion
Ecophysical	substitution
	resource efficiency (water, soil, raw materials)
	energy efficiency
	emissions reduction (air, water, soil, waste, human exposure)
	reduction of waste
	reuse and recycling
	renewable raw materials
	low-carbon (GHG emissions reduction)
	sustainable product design
	circular economy
	sustainable consumption
	life cycle consideration
	biodiversity
Social	quality of life
	fair working conditions and health and safety
	human and workers' rights
	fair (global, national, local)
	intergenerational justice
	education
	transfer of knowledge
Political/ Governmental	precautionary principle
	polluter pays principle
	integrated decision-making
	international cooperation
	rule of law
	targeted legislation
	effective enforcement
Economic	sustainable economic innovations
	indicators

4 Important Legal and Other Political Activities Regarding Chemicals Management

This chapter contains an overview of the key aspects of selected activities of the three topic areas on an international, the European and the national levels, which have been evaluated on the basis of the GE criteria (chapter 4.1 to 4.2.4). Essentially, all measures initiated by federal agencies, European institutions, and governmental delegations on the international level were considered within this category. Besides legally-binding measures, also memoranda of understanding, discussions, implementation tools, and incentive schemes (agencies, governmental prices, funding etc.) were included. The selection aims to give an overview of all essential instruments and approaches as well as the underlying initiatives, which are by no means exhaustive.

For all topic areas, it has to be kept in mind that international or European regulations are implemented on a national level or that national approaches are extended on the European or international level.

4.1 Overview of Current Activities on Environment and Health

In order to provide a quick overview of the activities described in this chapter, all international, European, and national activities analysed in the topic area of E&H are listed in Table 4-1.

Table 4-1: Overview of important legislation and political activities in the topic area of E&H

International	WHO Public Health & Environment Global Strategy (PHE)
European	Environmental Health Action Plan for Europe (EHAPE) The Children's Environment and Health Action Plan (CEHAPE) EHP of the WHO Europe including the Parma Declaration on Environment and Health Health 2020 ECEH und Environment and Health Information System (ENHIS) The 7th Environment Action Programme (EAP) EU LIFE Programme (LIFE+) EU research framework programme (FP) Programmes of Community action in the field of health
National	Environment and Health Action Programme (APUG) German Environmental Specimen Bank (UPB) The Indoor Air Hygiene Commission (IRK) Environmental Research Plan (UFOPLAN) Action Plan for Consumer Protection in the Food Chain (Action Plan on Dioxin) Strategy of the Federal Government for the Promotion of Child Health Health Research Programme - Health for Everyone BMBF Framework Programme Research for Sustainable Development (FONA – SÖF)

Information in this chapter is based upon internet and literature research but also includes the results of the project "Synoptic

Assessment on Environment and Health Programmes and Strategies of European Member States and Identification of suitable fields of action for Germany."[2] Furthermore, the chapter contains experiences of the European human biomonitoring studies *ESBIO* and *COPHES* [COPHES 2012], supported by the research framework programmes FP6 and FP7, respectively. In addition, the presented information is based on the report on funding priorities of E&H in Germany *Umwelt und Gesundheit in Deutschland - Überblick über Institutionen, Forschungsprogramme und –projekte* [Kailer 2011].

The topic area of E&H largely overlaps with the field of public health (which is not the focus of this report) and with the topic area of CS.

Activities concerning occupational diseases, health and safety, and job security are discussed in the CS chapter (chapter 4.2.3). Accordingly, all activities connected to climate change and climate protection are mentioned in the SC chapter although climate change can significantly affect human health (see chapter 4.2.4). Global activities under UNEP with environmental health relevance such as the *Stockholm Convention*, the *Basel Convention*, the *Rotterdam Convention*, are discussed under CS (chapter 4.2.1).

4.1.1 International Activities

On an international level, E&H aspects are mainly dealt with and discussed by the WHO [WHO 2014c, WHO 2014d]. The *Global Strategy on Public Health and Environment (PHE)* defines the goals and key aspects of this field.

PHE Strategy: Already in 1993, WHO passed the *PHE* strategy as a framework for the implementation of the *Agenda 21* goals. The 2011 and 2012 strategies [WHO 2014d] focus on the growing health costs, the barely-changing life expectancies, and an increase in chronic diseases[3], which are partly the result of environmental impacts.[4] *PHE* aims at the development of effective political measures for an advanced scientific understanding of the connections between E&H and an improved monitoring of important risks.

The reduction of health inequalities in the world and the

[2] UFOPLAN FKZ 3711 62 2411

[3] diabetes, hyperlipidaemia, kidnexy damage, cancer, cardiac cycle diseases, chronic obstructive lung disease, etc.

[4] On the global scale, chemicals only rank umber 6 of the risks, contributing 1 to 2% to the overall burden

enhancement of the conditions in developing countries and countries in transition are further central elements of *PHE*. To achieve this, better education and training in the fields of health, climate change, and education in general are required. WHO indirectly supports low-carbon actions and the mitigation of climate change because these measures decrease the health risk as well [WHO 2011]. To prevent health impacts directly caused by climate change, thresholds for the emission of GHGs were established, and guidelines for adaptation strategies are provided.

Preventive measures of the WHO include, amongst others, *Collaborative Standards Development System (CSDS)* and standards for buildings and construction materials concerning the reduction of radon, lead, and asbestos exposition as well as other hazardous chemicals. In this context, it is a major goal of the WHO to reduce chemical risks by advanced production standards in countries with low labour costs. With these measures, the *PHE* strategy contributes to reducing diseases due to poor air conditions and GHG emissions. However, it concentrates on particulate matter, sulphur, and nitric oxides. Additional preventive measures of WHO related to chemical safety and workplace safety are discussed in chapter 4.2.3.

PHE in the context of the Global Health Observatory: According to WHO, 25 % of all avoidable risks are caused by environment factors, which could be prevented by good management strategies. Therefore, WHO monitors and registers the health effects of physical, chemical, and biological risk factors in its *Global Health Repository* and lists fatalities and morbidity rates for the most important causes [WHO 2014e]. Besides water, hygiene, and solid fuels, general air quality, passive smoking, and chemicals are analysed. However, only a few chemicals such as mercury and lead were considered. The website *quantifying environmental health impacts* [WHO 2014f] presents specific information concerning health impairment by environment risks. Between 2002 and 2004, impacts of 26 avoidable risks were analysed, and recommendations for their avoidance were given (precautionary principle, transfer of knowledge). Health topics [WHO 2014g] is an additional website by the WHO, providing qualitative and short information about health risks and a number of chemicals.

4.1.2 European Activities

European activities connected with E&H are influenced by the *European Environment and Health Process (EHP)* of the European WHO and by the activities of the European Commission. This includes the implementation of decisions of the 2nd and 4th European WHO Ministerial Conference in form of the *Environmental Health Action Plan for Europe (EHAPE*) and the associated *Children's Environment*

and Health Action Plan for Europe (CEHAPE).

Additional activities referring to a certain extent to chemicals management are in the area of responsibility of the Directorate-General for the Environment *(Environment Action Programme)*, the Directorate-General for Research and Innovation (Horizon 2020 - the European Framework Programmes), and the Directorate General for Health & Consumers (*Health for Growth*).

WHO Europe's EHP [WHO EURO 2014a]: Due to the rising indications for negative impacts to human health caused by a harmful environment, the EHP was introduced in 1989. It was the aim to develop a broad prevention approach for the protection of public health. The development of EHP is controlled by the ministerial conferences. In between these conferences, the European Environment and Health Ministerial Board (EHMB) is responsible for the enhancement of the international E&H strategies in Europe [WHO EURO 2013]. *EHP* follows the guideline of the *European Charter on Environment and Health* "Every individual is entitled to an environment conducive to the highest attainable level of health and wellbeing" [BMUB 2012a]. Thus, the charter prioritises health over economic growth and requests "health for all in Europe" [WHO EURO 1989]. Contracting states are obliged to assess and eliminate health hazards and to develop guidelines for the eradication of the threat. Over its entire life cycle, chemicals management should become as resource-saving and environmentally sound as possible.

The Parma Declaration [WHO EURO 2010] and its *Commitment to act* confirmed the protection targets of *CEHAPE* in 2010. Contracting states committed themselves to implement national programmes in order to generate equal possibilities for every child. These targets include a secure water supply and wastewater treatment, physical activity and a healthy diet as well as improved air quality, and an environment which is not contaminated in a chemical, biological or physical way. Paragraph 4 states, "We will address these challenges by setting up or strengthening existing mechanisms or structures that can ensure effective implementation, promote local actions and ensure active participation in the European Environment and Health Process" [WHO EURO 2010]. Thus, a fair and equal implementation of the targets in all joining countries is exceptionally important. By specific training, such as knowledge transfer and education, adolescents shall be more involved in this process, and their awareness for E&H shall be raised. According to the declaration, the prevention of threats is done by applying the precautionary principle. Furthermore, the declaration addresses the necessity of improving the international chemicals management. In 2016, the Ministerial Conference will check implementation of the targets [Jakab 2010].

The *WHO European Centre for Environment and Health (ECEH*) [WHO EURO 2014b] is a centre of scientific excellence of WHO/Europe. It supports *EHP* and provides information about environmental health risks. It also develops international guidelines and supports activities such as the follow-up to the Ministerial Conferences. The *Environment and Health Information System (ENHIS)* [WHO EURO 2014c] is an indicator system by ECEH, which provides information and documentation about public health in the WHO European Region. Data or fact sheets can be downloaded from the website. The information systems provides the data that is used as a basis for the implementation of the precautionary principle of the WHO's health strategy in Europe [WHO ECEH 2005]. The ENHIS database [WHO EURO 2014c] comprises information on all important WHO E&H topics (see also 4.1.1) and discloses them as fact sheets. This facilitates education and transfer of knowledge.

The *EHAPE* [WHO EURO & EU COM 1994], covering the time period from 2004 to 2010, focuses on the investigation of connections between environmental risks and diseases, and the identification, the information, and the communication of new risks. The creation of appropriate governmental mechanisms shall ensure that all decisions concerning the environment, and thus health, incorporate not only economic considerations but also environmental health risks, which is in accordance with the requirements of a sustainable development.

The action plan includes the following key topics:

1. Improvement of the information flow through the development of integrated environmental and health related information in order to better understand the causal links (actions 1 to 4[5]), closing of knowledge gaps through research on environment and health and identifying emerging issues (actions 5 to 8[6])
2. Review of politics and improvement of the communication through awareness-raising, risk communication and education (actions 9 to 13[7])

[5] Environmental health indicators, integrated monitoring of the environment, coherent approach to biomonitoring, coordination and joint activities on environment and health

[6] Integrate and strengthen European environment and health research, Target research on diseases, disorders and exposures, Develop methodological systems to analyse interactions between environment and health, Ensure that potential hazards on environment and health are identified and addressed

[7] Develop public health activities and networking on environmental health determinants through the public health programme, Promote training of professionals

The focus of the environmental health management tools (chapter 3) lies on environment and health information systems, assessment of health-related environmental hazards, control measures, economic and fiscal instruments, environmental health services, professional training and education, public information and health education, and research and technological development. In the field of specific environmental hazards (chapter 4), water, air, food, solid wastes and soil pollution, ionizing and nonionizing radiation as well as natural disasters and industrial and nuclear accidents are paramount. With a view on living and working environments (chapter 5), urban and rural settlements as well as occupational health and safety were considered. To protect the environment and human health, the *EHAPE* prompts the EU member states to promote the use of renewable energies and, where appropriate, the use of waste for energy production within their energy policy decisions. Regarding international cooperation (volume 3), the focal points were the support of emerging countries as well as on common transboundary problems. Substantial goals included international partnership and the establishment of a European Environment and Health Committee. Health risks in the different areas were estimated in cooperation with the *International Programme on CS (IPCS)* [WHO EURO & EU COM 1994] (see chapter 4.2.1). Currently, no second EHAPE is planned. However, important E&H objectives were integrated into the new EAP draft (see below).

The *CEHAPE* [WHO EURO 2004] is based on the decisions of the 4th Ministerial Conference on E&H in Budapest, which explicitly mentions the children’s rights to live in a healthy environment. Hence, the emphasis is on the accessibility to clean and affordable water, on accidents and injuries, on physical activity, on pulmonary diseases (in- and outdoor air quality), and on health risks due to hazardous chemicals as well as physical and biological agents. Rules and laws shall be passed in order to reduce the burden caused by dangerous chemicals (see also CS). In addition, the plan claims the integration of children’s health and the environment into the education and qualification of particular occupational groups to increase the knowledge in this field.

The *National Environmental Health Action Plans* (*NEHAP*) help to implement the postulations of *EHAPE* and *CEHAPE* within the member states (see *APUG* in chapter 4.1.3).

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and improve organisational capacity in environment and health by reviewing and adjusting risk reduction policy, Coordinate ongoing risk reduction measures and focus on the priority disease, Improve indoor air quality, Follow developments regarding electromagnetic fields

Besides the already-described activities in the topic area of E&H, the following chapter contains activities or initiatives which are either related to environmental and health aspects to a certain degree, or should contain elements of E&H in more detail.

Please note: The following plans of action and research framework programmes must not be only seen in the topic area of E&H as they also belong to the topic areas of SC and CS. Furthermore, they contribute to the efforts for a GE.

The *EAP* defines the basic conditions of political measures in the EU's environmental policy. The *6th EAP* (2002-2012) [EU COM 2014a] focused on the topics of air pollution, soil protection, and the use of pesticides and chemicals. The roadmap for the *7th EAP* (until 2020) [EU COM 2014b] emphasises environmental burdens, health risks, and the decrease in the quality of life. Moreover, the ecological limits of capacity as well as the problem of mixture toxicity and endocrine disruptors are addressed. An EU strategy for a non-toxic environment shall be developed that provides incentives for innovative and sustainable substitutes. International cooperation and alliances with emerging and developing countries are supported. According to the *7th EAP*, the EU has to become a "resource-efficient, low-carbon economy" [EU COM 2014b] that is competitive and sustainable. If necessary, indicators have to be developed in order to measure the countries' progresses. For a targeted environment policy, the data basis on substantial relationships between environment and health has to be improved and environmental monitoring as well as E&H indicators have to be enhanced.

The *LIFE Programme* is the funding instrument of the EU for the environment. "The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with European added value" [EU COM 2014k].

Framework Programme for Research and Technological Development (FP): The FP combines all support programmes for research and innovation of the European Commission. The major aspects of the *FP7* as well as those of *Horizon 2020* are described in the following paragraph. The *FP7* (2009 - 2013) is divided into the thematic areas i) Health, ii) Food, Agriculture and Fisheries, and Biotechnology, iii) Information and Communication Technologies, iv) Nanosciences, Nanotechnologies, Materials and New Production Technologies, v) Energy, vi) Environment (including climate change), vii) Transport (including Aeronautics), viii) Socio-economic Sciences and Humanities, ix) Space, and x) Security [EU COM 2012a]. Regarding the topic Health, the health of children and the ageing population are highlighted. The topic Environment and Climatic Changes focused on sustainable

environment and resource management and on the interactions between climate, biosphere, ecosystems, and human impacts.

Horizon 2020 [BMBF 2014], the new framework programme for research and innovation (2014-2020), aims at sustainable development. Key areas are sustainable and low-emission technologies for the energy intensive processing industry, sustainable management of natural resources and ecosystems, and the ensuring of sustainable provision with abiotic resources. Moreover, the competitiveness of European enterprises shall be increased; intelligent and sustainable growth shall be supported, and new market opportunities shall be developed. Other central elements are the protection of the climate system as well as eco-innovations. Societal priorities include health, demographic change, well-being, and an inclusive, innovative and secure society. International cooperation with third countries and international research and innovation in the European Research Area (ERA) shall be fostered to develop global rules and guidelines for the European industry.

The *Programme of Community action in the field of public health* (2003-2008) [EU 2008] focused on the promotion of public health, including the reduction of disparities in the health sector and the development and improvement of the level of knowledge [EU 2007]. Within the current action programme *Health for Growth* (2014-2020) [EU COM 2014c], the key elements are i) development of innovative and sustainable health care systems, ii) citizen's improved and assured access to healthcare, iii) health promotion and prevention of diseases, and iv) protection of humans against cross-border health threats (e.g. large-scale contamination with chemicals). An improved database for important determinants of human health, including potential environmental impacts, is another key aspect.

Health in Europe: Information and Data Interface (Heidi) [EU COM 2012b]: The database and information platform serves as an instrument for the collection and presentation of reliable and comparable information regarding Europe's health situation. It is therefore generally similar to the WHO's *Global Health Observatory*. The information refers to the status and to the factors of health as well as to systems and strategies within the EU. Chemicals are only marginally considered as environmental factors.

4.1.3 National Activities in Germany

In Germany, the topic area of E&H is dominated by *APUG*, which is implemented by *EHAPE* and *CEHAPE* on a national level. Further important activities related to environmental health exist, such as the *Environmental Specimen Bank*, the *German Environmental Surveys (GerES)*, the *Indoor Air Hygiene Commission*, the *Human Biomonitoring Commission*, the *Environmental Research Plan (UFOPLAN -*

Umweltforschungsplan), the *Action Plan on Dioxin* by the Federal Ministry of Food and Agriculture (BMEL) or the *Health Research Programme* and *Strategy of the Federal Government for the Promotion of Child Health* of the Federal Ministry of Health (BMG) and its agencies. A cooperation of BMUB and VCI to develop and validate new analytical methods is, despite its political background, discussed as a voluntary initiative in E&H, chapter 5.1 within this report.

The UBA provides an excellent summary of all German activities connected to E&H in its 2011 report *Environment and Health in Germany - Overview on Institutions, Research Programmes and Projects* [Kailer 2011].

Due to the federal structure of Germany, the topic area of E&H is addressed on both the federal and provincial level. However, this report is restricted to national activities. Here, contributors include the BMUB, the BMG, the BMEL as well as their subordinate agencies [UBA, Federal Agency for Nature Conservation (BfN), Federal Office for Radiation Protection (BfS), Robert Koch Institute (RKI), and the Federal Institute for Risk Assessment (BfR)]. In addition to the ministries and agencies directly related to the *APUG*, environment and health topics in the responsibility of the Federal Ministry of Labour and Social Affairs (BMAS) and the Federal Ministry of Education and Research (BMBF) are examined. On the level of Federal States, the topic area is mainly stimulated and addressed by the respective State Ministry for Environment and/or Health or the respective subordinate authorities.

APUG (*Aktionsprogramm Umwelt und Gesundheit - Environment and Health Action Programme)* [APUG]*:* The *APUG* is embedded into the European process for environment and healthcare, and its emphasis lies on topics relevant to the European region. As several ministries and subordinate agencies are involved, *APUG* constitutes an important integrating function. So far, topics within *APUG* are mainly related to indoor air, radiation (optical, UV, ionising radiation), electromagnetic fields, noise, and environmental medicine. Chemicals play a major role in the analysis of environmental risks. Aspects of environmental justice were considered in environmental surveys as well as in health surveys.

The sole action plan of a Federal State (*APUG NRW*) [APUG NRW 2010] thematically covers similar topics as the APUG but focuses on different aspects in certain topics. In the past, the major interests of the plan were traffic (reduction of pollutant and GHG emissions), noise and pollutant emission, healthy living (construction materials), and the provision of information and knowledge. The Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the

German State of North Rhine-Westphalia (MKULNV) is currently working on a master plan for E&H to further reduce the pollution and burden for the public, to raise responsible awareness for environmental issues, and to achieve high qualities of living for all parts of society.

Within the research project „Synoptic Assessment of Environment and Health Programmes and Strategies of European Member States and Identification of suitable Fields of Action for Germany[8],“ recommendations for the advancement of *APUG* were prepared.

The *German Environmental Specimen Bank (UPB)* [UBA] is in the UBA’s area of responsibility and constitutes a central element for both environmental observations and monitoring of the exposure to environmental chemicals of the general public in Germany. Since 1974, representative samples of soil, suspended particles, plants, animals, and humans have been systematically saved and thus allow for retrospective analysis. Via trend analysis, the BMUB receives scientific background information and is able to take action in the protection of nature and environment. Moreover, the BMUB can control the effects of those measures with the data from the *UPB*. The database also plays an important role in further developing public policy in the fields of environment and nature protection, e.g., for the establishment of limits and for prioritisation [UBA 2008]. As *UPB* is also a guideline for other environmental observation programmes, it is of growing importance to bilateral, multilateral, and supranational cooperation.

German Environmental Surveys (GerES and KUS): Since 1985, a nationwide HBM is conducted regularly by the UBA to analyse the chemical body load status of the German population. Among them are the *GerES I-IV and* the *Kinder-Umwelt-Survey 2003/06 (KUS – Environmental Survey for Children)*. The surveys contain data which are the basis for the HBM Commission’s health based guidance values. This value of a chemical substance in a human being (e.g. from urine or blood) defines the actual value for a certain group of society in a certain area or land.

Indoor Air Hygiene Commission (IRK) [UBA 2013a]: The main task of the IRK is issuing recommendations and statements on various subjects connected to indoor air hygiene. Among them are guideline values for organic compounds, dearomatised hydrocarbon solvents, mercury vapours, carbon monoxide, and nitrogen dioxide. Thus, the commission supports the reduction of hazardous emissions into the

[8] UFOPLAN FKZ: 3711 62 241 1

environment, which would subsequently harm human health. Examples for indoor air hygiene include biological contaminations of the indoor air and substance emissions from furniture and construction materials [UBA 2013]. In addition, IRK edits guidelines for consumers, which present advice for preventive measures. With these activities, the commission adds to the improvement of the quality of life and the well-being of humans in their living environment.

In addition to the E&H activities in a narrow sense, the following section introduces national activities where E&H is part of the general objective.

UFOPLAN: The need for research derived from BMUB activities is annually defined in an *UFOPLAN.* Thus, the plan is a key political activity for the topic areas of SC and CS.

A key topic of the *UFOPLAN 2014* [BMU 2013] is the risk posed by chemical substances and preparations. The evaluation of potentially harmful environmental conditions is especially an area where research is required as it is a precondition for risk management and substitution (substitution, precautionary principle). Research shall contribute to the products and services that are produced and used as environmentally-friendly and resource-saving as possible (target 11). This also comprises sustainable consumption. The improvement of a closed cycle economy and of life cycle considerations shall be implemented by specific research projects within the *UFOPLAN 2014*.

The *Action Plan on Dioxin* (*Action Plan for Consumer Protection in the Feed Chain)* [BMELV 2011] is within the area of competence of the BMEL. It comprises topics such as the monitoring system for food and feedingstuff regarding contamination with hazardous substances on the levels of enterprises, on the federal states, and on the national level. Furthermore, the plan contains strategies to guarantee food safety for consumers and is only indirectly related to the chemical industry. The Action Plan covers measures to regulate and monitor dioxin exposure in feedingstuff in order to implement the *German* legislation on food and feedingstuff. It is the goal to oblige producers of forage to test their fats, oils, and processed goods for dioxin (targeted legislation).

The *Strategy of the Federal Government for the Promotion of Child Health* [BMG 2008] aims at the prevention and health promotion, promotion of equal opportunities, reduction of health risks, fundamental research, detection of risks and protective factors, and the physical health of the target group. The Federal Government’s strategy has its origin in the results of the *Study on the Health of Children and Adolescents in Germany (KiGGS)* between 2003 and 2006. The study showed that the probability for diseases is unequally distributed as children from socially disadvantaged families have a

higher risk of suffering from diseases, obesity, or psychological anomalies. To counteract this development, the Federal Government combined several initiatives and introduced new measures to improve the quality of life of the respective children and to create equal living conditions [BMG 2014].

Health Research Programmes: Health research fosters the development of new and improved diagnostic methods and therapies. In addition, new approaches of prevention are generated as they can avoid diseases from occurring.

Forschung für den Menschen (research for humans, 2011 to 2014): Amongst others, the programme contains research priority areas on prevention and nutrition, healthcare industry, and global cooperation [BMBF 2010].

FONA, the Framework Programme Research for Sustainable Development, by the BMBF is introduced in chapter 4.3.6. Its focus is on socio-ecological research, but it also contains subjects relevant to E&H such as climate change, agricultural, and nutrition research. Relevant examples include i) the Project Nutritional changes: strategies for socio-ecological transformations in the societal action field of environment-nutrition-health, ii) strategies for Coping with Systemic Risks (information and communication technologies, pharmaceuticals in drinking water, impacts of overweight and obesity, and iii) from Knowledge to Action - New Paths towards Sustainable Consumption.

4.1.4 Activities from Other Countries

The USA's *National Health and Nutrition Examination Survey (NHANES)* [CDC 2014] or the Canadian, Japanese or South Korean monitoring programmes are good examples for comprehensive monitoring of the general public regarding environmental pollutants. Within *NHANES*, operating since 1999 on an annual basis, examinations of the health status, questions concerning potential sources of exposure, and human samples are combined. The samples are regularly analysed concerning a range of chemical contaminations.

The *NEHAPs* of Denmark and Sweden as well as the French programme, in particular, are interesting regarding chemical management and CS. Detailed results of the major aspects can be found in the final report of the project "Synoptic Assessment of Environment and Health Programmes and Strategies of European Member States and Identification of suitable Fields of Action for Germany[9]".

[9] UFOPLAN: FKZ: 3711 62 241 1

4.1.5 Summary Evaluation of the Fulfilment of Green Economy Criteria through Activities on Environment and Health

The following section summarises how far the single GE criteria, which have been defined for this project, are implemented by political activities in the topic area of E&H. This provides an informative basis for the contribution to a GE and thus for the recommendations given in chapters 7 and 8. A detailed table containing the most contributing activities for each criterion can be found in appendix III of the German report. The evaluation showed that the identified E&H activities on international, European and national levels contribute significantly to a GE although this is hardly recognised in public discussions. This is especially true for the following:

- ✓ development of indicators (measures beyond GDP)
- ✓ precautionary principle
- ✓ international cooperation
- ✓ targeted environmental legislation
- ✓ transfer of knowledge
- ✓ quality of life
- ✓ integrated decision-making
- ✓ fairness (environmental justice global-local)
- ✓ effective enforcement
- ✓ education
- ✓ rule of law

To a smaller extent, this is also valid for the following:

- ✓ energy efficiency
- ✓ climate protection (low-carbon)
- ✓ emissions reduction
- ✓ life cycle assessment
- ✓ substitution
- ✓ biodiversity

4.2 Overview of Current Activities on Chemical Safety

Regarding the objective of CS, chemicals policy is strongly affected by legal frameworks and international treaties because of its global significance, connection, and risks. Due to the broad field of application of chemicals in various areas of life, a strong subdivision of legislation exists, which justifies a differentiation

into chemicals in general, health and safety at work, waste management and the *Ordinance on Hazardous Substances*, and water and emission control. Prohibitive or restrictive measures for chemicals of particular groups of products are mentioned but not analysed in detail. For a better overview, Table 4-2 provides a list of all international, European, and national activities in the topic area of CS.

Table 4-2: Overview of important legislation and political activities in the topic area of CS

International	The Strategic Approach to International Chemicals Management (SAICM) Globally Harmonised System (GHS) Rotterdam Convention Stockholm Convention Minamata Convention WHO International Programme on Chemical Safety (IPCS) with INCHEM database, EHC, CICADs, ICSC, PDS, IRA, RAN UNEP Activities: Responsible Production, Flexible Framework, APELL, CiP, Industrial Ecology OECD EHS Programmes with CSB, CoCAP, SIDS, QSAR, Sustainable Chemicals Platform, PRTR, test guidelines, good laboratory practice WHO Global Plan of Action on Workers' Health Programme on Safety and Health at Work and the Environment (ILO) UNECE Water Convention Basel Convention
European	Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP) Regulation (EU) No 649/2012 of concerning the export and import of hazardous chemicals (PIC) Regulation (EC) No 850/2004 on persistent organic pollutants (POPs) Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work (Exposure to chemical agents) Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (CMD) Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work (CAD) Directive 2010/75/EU on industrial emissions (IED) with Regulation (EC) No 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register (E-PRTR) Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (Seveso) Directive 2000/60/EC establishing a framework for Community action in the field of water policy (EU Water Framework Directive) Regulation (EC) No 1013/2006 on shipments of waste Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market (PPP) Regulation (EU) No 528/2012 concerning the making available on the market and use of biocidal products (BPR) Regulation (EC) Nr. 648/2004 on detergents (Detergents Regulation) Directive 2001/83/EC on the Community code relating to medicinal products for human use (MPs)

	Directive 2011/65/EU restricting the use of hazardous substances in electrical and electronic equipment (RoHS)
National	Chemicals Act (ChemG) Occupational Safety and Health Act (ArbSchG) Occupational Safety Act (ASiG) German Ordinance on Hazardous Substances (GefStoffV) The easy-to-use workplace control scheme for hazardous substances (EMKG) of the German Federal Institute for Occupational Safety and Health (BAuA) and the Joint German Occupational Safety and Health Initiative (GDA) Federal Immission Control Act (BImSchG) Federal Water Act (WHG) Electrical and Electronic Equipment Act (ElektroG) Plant Protection Act (PflSchG) Fertiliser Ordinance (DüMV) Fertilising Ordinance (DüV) Detergents and Cleaning Products Act (WRMG) Medicinal Products Act (AMG) Ordinance on the restriction of the use of certain hazardous substances in electrical and electronic equipment (ElektroStoffV)

4.2.1 Important International Regulations on Chemical Safety

The most important international instruments regarding safe chemicals policy are the *Inter-Organization Programme for the Sound Management of Chemicals (IOMC) and SAICM* with the *Globally Harmonised System (GHS)* and international treaties on chemicals management such as the *Rotterdam Convention*, the *Stockholm Convention*, and the *Minamata Convention*. Furthermore, *WHO's IPCS* and the UNEP activities *Flexible Framework Programme, Responsible Production* and *Awareness and Preparedness for Emergencies at Local Level (APELL)* are worth mentioning in this context. Another important programme on the global level is the OECD *Environment, Health and Safety (EHS)* programme, which globally tries to harmonise measures of chemical safety and chemical policy in OECD member countries and partner countries.

Some of the CS instruments contribute significantly to sustainable chemistry as well (see chapter 4.3). European regulations can be found in chapter 4.2.2.

IOMC [WHO 2014g]*:* Within the *IOMC*, operating since 1995, the Food and Agriculture Organization of the United Nations (FAO), the International Labour Organization (ILO), UNEP, the United Nations Industrial Development Organization (UNIDO), the United Nations Institute for Training and Research (UNITAR), WHO, World Bank, and OECD work jointly on the coordination of international activities for environmentally-friendly chemicals management. The programme will be continued until 2020. The *IOMC* is located at the WHO and, in 2006, organized the first *International Conference on Chemicals Management (ICCM)* together with UNEP and IFCS, which took place in

Dubai. The conference contributed to the development of *SAICM* (see chapter 4.3).

SAICM [SAICM]*:* Based on a request by the first World Summit in Johannesburg (2002), a strategic approach for international chemicals management, *SAICM*, was agreed upon on the *ICCM1* in 2006. It aims at combining the numerous single initiatives concerning chemicals management. However, it is not legally binding.

Until 2020, SAICM aims at transforming the production and handling of chemicals in a way that all negative impacts on human health and the environment would be minimized. In its projects, SAICM considers the precautionary principle. Thus, hazards emanating from chemicals are detected systematically and preventive measures are taken. Until 2020, chemicals that pose a disproportionate or uncontrollable threat shall be prohibited. Prohibitions shall be based on a scientific Analysis of Alternatives (AOA) and a socio-economic analysis (SEA) [UNEP 2006]. In compliance with *SAICM*, the reduction of risks by prevention, reduction and restoration along the entire life cycle is the precondition for sustainable chemicals management. Therefore, it should include goods and products where applicable. *SAICM* demands the consideration and protection of the most vulnerable groups or ecosystems in all decision-making processes concerning chemicals. To foster global justice, the differences in the abilities of sustainable chemicals management between industrialized nations and developing and transition countries shall be eradicated by technical and financial support, and illegal international transport of hazardous substances or waste shall be disabled. *SAICM* is a global commitment to protect future generations from chemical risks. It wants to achieve an effective and efficient control of chemicals management by transparency and active participation of all groups of citizens.

The *Overarching Policy Strategy (OPS)* of *SAICM* consists of i) risk reduction, ii) improvement of knowledge and information, iii) good governance, iv) development of capacities and technical cooperation, and v) containment of illegal international transport.

The identification of global risks plays a major role in the context of risk reduction. Emerging issues are topics of global importance with the necessity to close information gaps. So far, the following themes have been identified as emerging issues:

1. lead in paints
2. nanotechnology and manufactured nanomaterials
3. chemicals in products
4. hazardous substances within the life cycle of electrical and electronic products

5. endocrine-disrupting chemicals
6. perfluorinated chemicals and the transition to safer alternatives (PFCs)

Guidelines for specific measures and instruments for chemical management are listed in the *Global Plan of Action (GPA)* separated into 36 specific working areas. Hence, GPA is the code of practice for countries to achieve the 2020 goal. The *Quick Start Programme (QSP)* enables *SAICM* to work with funding instruments and incentives through prices.

So far, two Dubai follow-up conferences have taken place, which elaborated on the progress and the future priorities. The 2009 *ICCM2* in Geneva focused on the cooperation with the WHO, and the *ICCM3* in 2013 in Nairobi, for the first time, evaluated the 20 indicators of progress.

As a consequence, *SAICM* does not only constitute an instrument for CS but contributes also considerably to sustainable chemistry (see chapter 4.3.1) and the principles of a GE.

GHS: chapter 19 of *Agenda 21* proposes the establishment of a consistent global system for the classification and labelling of chemicals under the direction of the UN. In 2003, the GHS was submitted with the so-called *purple book.* Since then, it is continually refined and updated every two years. The existing approaches for classification and labelling have their origins in several sectors, such as transport, consumer-, employer-, and environmental protection and are now harmonised within the *GHS*. In addition, states that do not have such regulations shall be included. Therefore, *GHS* serves as a benchmark for the evaluation (classification), labelling, and communication (safety data sheet) of hazards due to chemicals. However, *GHS* is not directly legally effective as this requires the implementation by the single states or communities of states. Major industrialised countries, such as the USA, underline the fact that they do not consider it binding. This is reflected in the current discussions concerning the Transatlantic Trade and Investment Partnership (TTIP). Within the GHS, several types of risks are arranged in hazard classes, which differentiate between acute and chronic effects. The type of hazard is described by hazard classes [UBA 2007].

Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade: The aim of the convention is to control the international trade of chemicals. In order to assess the chemicals' risks, states importing chemicals shall be provided with sufficient information concerning the handling and evaluation of these substances. This includes their toxicological, ecotoxicological and safety-related data. Therefore,

the *Prior Informed Consent (PIC)* procedure regulates that chemicals must only be imported if the receiving country agrees to the import based on preliminary information [FAO & UNEP 2011]. As most of the importing nations are developing and emerging countries, the Rotterdam Convention is targeted at improving information and cooperation between the countries. Hazardous chemicals that are subject to regulation and supervision are listed in the appendices, which can be expanded and adjusted if necessary [FAO & UNEP 2010].

Stockholm Convention on Persistent Organic Pollutants (POPs) [Stockholm Convention 2008]: The Stockholm Convention entered into force in 2004. It is a global agreement on the cessation and constriction of the production, use, and release of particular POPs, and it contributes to the gradual substitution of hazardous substances. Furthermore, the convention asks for the reduction of emissions into the environment. The lists of substances, currently containing 23 substances, are checked and expanded continuously. The convention is based on the polluter pays principle and supports international cooperation and knowledge transfer.

An additional POPs-related protocol, the so-called *Aarhus Protocol*, exists under the *Convention on Long-Range Transboundary Air Pollution (LRTAP)* on the level of the United Nations Economic Commission for Europe (UNECE) [UNECEa].

Throughout the last years, activities connected to the Rotterdam and Stockholm Convention have been coordinated more strongly to take advantage of the synergies and to optimise the protective effect. The Basel Convention, introduced in chapter 4.2.6, is embedded into these synergies.

Minamata Convention [WHO 2014h]: The convention, which has been agreed upon in 2013, aims at curtailing the emissions of mercury on a global level. With its entry into force, the prospective contracting states are obliged to reduce their use of mercury in industrial production processes tremendously and to store and dispose their mercury waste only under strict conditions. Moreover, the contracting states must not open new mining sites for mercury; small-scale business gold mining has to implement health and safety measures, and new coal-fired power plants have to use BAT procedures to prevent mercury emissions. According to articles 8 and 9, the contracting states are also obliged to reduce the emissions of mercury from listed sources into air, soil, and water. From 2020 onwards, particular illuminants, thermometers, and mercury-containing pesticides and biocides will be prohibited.

International Programm on Chemical Safety (IPCS) [WHO 2014i]: WHO’s *IPCS* serves the establishment of a scientific background for emission-reduced and climate-friendly chemicals management all over

the world. Important aspects are the strengthening of the capabilities and the capacities in developing and emerging countries. *IPCS* lists mercury, lead, fluoride, dioxin and dioxin-like substances, cadmium, benzol, asbestos, arsenic, and pesticides as (a group of) chemicals of particular importance for public healthcare and demands substitution, wherever possible. In support of these targets, the programme offers a variety of activities and information. With targeted upgrading of the capacities and cooperation with national and local agencies, *IPCS* ensures effective enforcement of appropriate chemicals management.

The *INCHEM* database is an important part of the *IPCS* programme as it provides electronic information on CS and chemicals management [IPCS]. Additional instruments are *Environmental Health Criteria (EHC)*, *Concise International Chemical Assessment Documents (CICAD)*, and *International Chemical Safety Cards (ICSC).* The *EHC* standardise and combine the international state of knowledge on toxicological and ecotoxicological effects of chemicals exposure. Furthermore, the documents contain recommendations for the protection of exposure risks. *CICADs* are concise information documents with practical examples on exposure limits. In a standardised manner, *ICSCs* contain basic information on the chemicals, on the first aid measures in case of an accident, and on the appropriate use, packaging, storage, and labelling of chemicals. They are comparable to the *SDSs* of hazardous substances that have to be provided in Europe.

Similar information is also given in *Pesticide Data Sheets (PDSs),* which are developed by WHO in cooperation with FAO. Through an *Integrated Risk Assessment (IRA)*, harmful impacts on humans and the environment, that result from the production, application, and transport of chemicals, shall be prevented, and an adequate risk management shall be established. [WHO 2001]

In July 2013, the WHO *Chemical Risk Assessment Network (RAN)* was founded. It serves the *IPCS* as a forum for information exchange and worldwide coordination of chemicals risk assessment. The network’s purpose is to detect incomplete knowledge and new risks and to build a forum for scientific exchange and communication (precautionary principle, education, transfer of knowledge). Key tasks are the support of good practice and the harmonization of methods, facilitating the identification of research priorities and new risks, technical exchange, capacity building, and the exchange of working packages in order to prevent duplications. Besides giving attention to risks through direct contact to chemicals, the WHO network is also concerned with risks of exposure from the environment (water, soil, air) or from food.

Activities of UNEP on chemicals safety:

Responsible Production [UNEPb] is an approach by UNEP that offers guidance and support for sustainable production processes of SMEs (Framework Booklet, Guidance and Toolkit, Training Package) to improve the risk management within the value-added chain. It was developed to increase the general safety and to reduce accidents along with their social, economic, and ecologic consequences (precautionary principle, integrated decision-making). The programme offers assistance to enterprises and other relevant actors to understand and cope with the risks of chemicals. The toolkit is of special importance as it suggests, for instance, specific measures and instruments to replace hazardous chemicals (transfer of knowledge, enabling education). At the same time, the programme *Awareness and Preparedness for Emergencies at Local Level (APELL)* aims at the on-site prevention of accidents. The *Flexible Framework Initiative* offers possibilities for developing and emerging countries to learn from and to transfer experiences of industrialised countries. By means of pilot projects, guidelines are developed, *Chemical Accident Prevention and Preparedness (CAPP)* programmes are supported, and *Implementation Support Packages* are elaborated. The *Chemicals in Products Project (CiP)* of UNEP helps to clarify the responsibilities for products over the entire life cycle in order to protect vulnerable groups against harmful inputs into these goods. Generally, the sustainability of products shall be improved by information exchange concerning a product’s inputs among all contributors in a production chain. In addition, consumers and political decision-makers shall be embedded into the information process. UNEP also supports the concept of *Industrial Ecology (IE),* which demands a system-orientated study of the physical, chemical, and biological interactions and interdependencies between industry and the ecosystem. The principles of *IE* focus on system analysis, material and energy flows, transformations, multidisciplinary perspectives, recycling/reuse, waste avoidance, consumer embeddedness, energy efficiency, resource efficiency, and innovation. This concept mainly addresses the detailed compilation and subsequent improvement of material and energy flows in the industry [ISIE].

OECD’s Environment, Health and Safety (EHS) programme for the assessment of chemicals is the overarching programme for harmonising the utilised methods concerning chemical safety and chemicals policy. The core tasks are harmonisation, burden-sharing, and knowledge transfer. The *EHS* aims at a common elaboration and validation of internationally available test methods for chemicals (Test Guideline Programme) and of the principles of good laboratory practice (GLP) with respect to chemicals assessment (Hazard Assessment Programme). The latter programme involves the development of assessment tools such as *Quantitative Structure-Activity*

Relationships (QSAR). Furthermore, the *Sustainable Chemicals Platform* was developed under the *Risk Management Programme.* Within the OECD *Cooperative Chemicals Assessment Programme (CoCAP)*, the threats posed by chemicals are evaluated using a cooperative approach between the contracting states in order to achieve faster classification results. To evaluate the potential damage, a *Screening Information Data Set (SIDS)* is generated. This dataset includes validated information on physico-chemical properties, distributions and behaviour of substances in the environment, and data on ecotoxicology and its impact on humans. In case of data gaps for single substances, the chemical industry has to conduct experimental analysis on behalf of the responsible national authorities. [FhG]

4.2.2 Important European and German Regulations on Chemical Safety

On a European level, the most important chemicals directives are the *Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)*[10] and *Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP)*[11]. These combine all aspects of safe (and sustainable) chemicals management.

The *Regulation (EU) No 649/2012 of concerning the export and import of hazardous chemicals (PIC)*[12] implements the Rotterdam Convention on a European level while ECHA coordinates the effectiveness of the implementation.

The *Regulation (EC) No 850/2004 on persistent organic pollutants (POPs)*[13] implements both of the international POP conventions (*Stockholm Convention* and *Aarhus Protocol*) and contains additional rules. Among them are instructions for production, marketing, use, and disposal of POPs with the overall goal of substitution and emissions reduction.

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[10] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

[11] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures

[12] Regulation (EU) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of hazardous chemicals

[13] Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29 April 2004 on persistent organic pollutants

REACH:[14] The regulation addresses substances, mixtures, and products. It aims at assuring a high level of protection of human health and the environment by facilitating the free trade of chemicals on the domestic market and increasing competitiveness and innovation at the same time. *REACH* is based on the principle that producers, importers, and downstream users take responsibility for their chemicals.

Besides the registration of all substances on the market - the forwarding of a dataset concerning the respective substance to the ECHA - *REACH* launched communication requirements of substances along the supply chain and regulates restrictions of substances. It creates the prerequisites for the detection and promotion of risks posed by chemicals. The regulation is targeted at enhancing the safety during the production and application of chemicals.

CLP:[15] The Regulation implements the *GHS* on the European level. According to the *CLP regulation*, all chemicals are subject to classification and labelling requirements prior to their marketing in order to underline their hazardousness. Since 1st December 2010, the regulation has to be applied for substances; for mixtures, it will be binding from 1st June 2015 onwards. Unlike *REACH*, which focuses on an appropriate control of risks, *CLP* addresses the inherent properties.

Amongst others, the regulation defines the following:

- ✓ Classification, labelling and packaging requirements for suppliers
- ✓ Criteria necessary to classify substances and mixtures
- ✓ Packaging and labelling of substances and mixtures classified as hazardous
- ✓ Mixtures that require special labels.

The *CLP regulation* is designed to ensure a high level of protection for human health and the environment by facilitating the free trade of chemicals on the domestic market and increasing competitiveness and innovation at the same time. Furthermore, the regulation obliges all enterprises willing to sell hazardous chemicals to follow the

[14] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency

[15] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures

standardised criteria of *CLP.* The consistent classifications and labels also improve international cooperation and foster knowledge transfer concerning the hazards due to the increasing distribution. In addition, the regulation defines exposure limit values, which protect not only the employees on their workplaces but also the general public (labour and human rights).

The regulation adapts the UN's *GHS* standard to European requirements. The *GHS* modules are selected in a way that their subjects are in accordance with *Council Directive 67/548/EEC on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances*[16] and with *Directive 1999/45/EC concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations*[17] and that they are consistent with the regulations of the *Directive 2008/68/EC on the inland transport of dangerous goods*[18]. To ensure the current level of protection, *CLP* contains elements of the dangerous substance and the dangerous preparation directives, which cover hazards (e.g. single hazard statements) that are not covered on an UN level.

[16] Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances

[17] Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations

[18] Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods

In total, 28 hazard classes (16 physical hazards, 10 health risks, 2 environmental hazards) are defined within the *CLP regulation*. Self-dependent classification of substances and mixtures by producers or importers (self classification) are regulated as well as officially required classifications (harmonised classification).

European legislation on mercury: On the EU level, the *Regulation (EC) No 1102/2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury*[19] prohibits all exports of mercury-containing substances. Furthermore, mercury emanating from certain industrial sectors is considered to be waste and has to be disposed; the regulation specifies requirements for safe deposition. Besides this specific regulation, a broad range of European laws is concerned with restrictions and bans of mercury in products (e.g. certain measurement devices) and industrial processes (e.g. in the chlor-alkali industry). These rules are mainly parts of *REACH*, the *IED*, and the relevant BAT reference documents. The EU aims to accede to the new multilateral *Minamata Convention* as soon as possible and to adapt the Convention into EU laws accordingly.

On a national level, *REACH* and *CLP* are implemented by the *German Ordinance on Hazardous Substances (GefStoffV)* and the *Chemicals Act (ChemG),* which includes biocides and pesticides as well.

The *ChemG* regulates the responsibilities of the implementation processes, which are directly specified in *REACH*. The classification and labelling under *CLP*, however, is carried out according to the *GefStoffV.*

The *GefStoffV*[20] serves to protect humans and the environment against substance-related damages by including regulations of classification, labelling, and packaging of hazardous substances and formulations (see *CLP*), measures for the protection of employees and persons handling the hazardous substance (health and safety), and restrictions of producing and applying certain substances, formulations, or products.

[19] Regulation (EC) No 1102/2008 of the European Parliament and of the Council of 22 October 2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury

[20] "Gefahrstoffverordnung vom 26. November 2010 (BGBl. I S. 1643, 1644), die zuletzt durch Artikel 2 der Verordnung vom 15. Juli 2013 (BGBl. I S. 2514) geändert worden ist"

4.2.3 Important International, European, and National Activities on Occupational Health and Safety

On a global level, the most important activity on health and safety is the *WHO Global Plan of Action on Workers' Health*. On the European level, these are represented by the *EU Framework Directive on Safety and Health at Work*[21] along with the associated *Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work (CAD)*[22] and the *Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (CMD)*[23]. In Germany, regulations are managed through the *Occupational Safety and Health Act (ArbSchG)* and the *Occupational Safety Act (ASiG)*.

Global Plan of Action on Workers' Health 2008-2017 [WHO 2007]: The plan implements the WHO strategy *Safety and Health at Work* and aims at minimising the health risks on the workplace by specific measures of prevention and control. It focuses on the development of effective mechanisms of collaboration and cooperation with developing and emerging countries. The requirements of the plan of action shall be implemented, monitored, and met by the targeted national regulations.

ILO's *SafeWork Programme (Programme on Safety and Health at Work and the Environment)* [ILO 2014]: The programme is based on the principle that fair work has to be safe work too and that global awareness has to be raised. The communication about the dimensions, the consequences of occupational accidents and diseases, and the implementation of health and safety programmes are the major objectives. Therefore, ILO manages the International Occupational Safety and Health Information Centre, which cooperates with national health and safety authorities in over 100 countries and publishes health and safety codes and recommendations. Major subjects include gender equality, child labour, and labour inspections [ILO].

The *Directive on the introduction of measures to encourage improvements in the safety and health of workers at work (89/391/EEC)*, which is often referred to as the EU *Framework Directive on Safety and Health at Work*, regulates the guidelines for

[21] Council Directive of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work (89/391/EEC)

[22] Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work

[23] Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work

occupational health and safety within the EU. Included in this system, with regard to the risk posed by chemical substances, are the *Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work* (*CAD Directive)*, single regulations for limits of exposure, and the *Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work (CMD Directive)*.

ArbSchG:[24] In Germany, the BMAS is responsible for occupational health and safety. The EU regulation is transferred to national law by the legal frameworks. The *ArbSchG* regulates the obligations and activities of safety and health protection of employees at work (working conditions, workers' rights). Important aspects of the laws are, amongst others, the obligations of the employer to substitute hazardous substances with less harmful ones (§7), to apply processes that prevent hazardous emissions on the workplace (§4), and to take precautionary measures in order to store and handle substances listed in the *GefStoffV* correctly. On the basis of this law, the employer is committed to a variety of measures for risk assessment and risk reduction, which are checked by the responsible governmental authorities (§21).

ASiG:[25] The *ASiG* contains essential regulations about the company's organisational structures for dealing with health and safety and mainly affects the adherence or the implementation of the *ArbSchG* and of measures to prevent accidents. Comparable to the emphasis of the *ArbSchG*, the key issues of the law are the protection of employees as well as the assurance of their rights for non-harmful workplaces. This also includes measures of monitoring requirements and their implementation by the responsible national authorities.

The easy-to-use workplace control scheme for hazardous substances (EMKG): The Federal Institute for Occupational Safety and Health (BAuA) is a governmental research institution of the BMAS and thus the major consultancy and control body concerned with the risks for health and safety of the employees. With *EMKG*, BAuA has developed a systematic set of guidelines to assess the risks of certain

[24] "Arbeitsschutzgesetz vom 7. August 1996 (BGBl. I S. 1246), das zuletzt durch Artikel 8 des Gesetzes vom 19. Oktober 2013 (BGBl. I S. 3836) geändert worden ist"

[25] "Gesetz über Betriebsärzte, Sicherheitsingenieure und andere Fachkräfte für Arbeitssicherheit vom 12. Dezember 1973 (BGBl. I S. 1885), das zuletzt durch Artikel 3 Absatz 5 des Gesetzes vom 20. April 2013 (BGBl. I S. 868) geändert worden ist"

occupations working with hazardous substances. As a result, it is possible to act quickly and in a preventive manner, which is independent of the level of knowledge and training of the assessor. If a situation requires action, the necessary measures are regulated within the *GefStoffV* [Kahl et al. 2012]. Through a research and development program, BAuA supports studies on risk assessment as a basis for science-based solutions within politics and practice [BAuA 2013].

Joint German Occupational Safety and Health Initiative (GDA): The *GDA* is a long-term intensive action of the federal states and government as well as accident insurance companies to strengthen occupational health and safety. An improved organisation of health and safety of workers and the reduction of the frequency and severity of accidents, amongst others with the handling of chemicals, are of particular relevance. Another important aspect of *GDA* is to coordinate the different regulations and guidelines of the state and insurances to create a comprehensible and consistent legal instrument for occupational health and safety [BMAS 2013]. The *GDA* combines the different activities of prevention for health and safety and creates incentives for companies to run a long-term policy of prevention. This will, in the medium run, improve the average level of protection. Moreover, the strategy fosters the assurance of secure, healthy, and humanly working conditions [GDA 2007].

4.2.4 Immission Control

On a global level, e.g. the *Stockholm Convention*, the *Aarhus Protocol*, and the *Minamata Convention* on mercury contain regulations for the reduction of emissions (see chapter 4.2.1).

The *IED* is the legal instrument on the European level, which combines the control of emissions into all parts of the environment with process optimisation (BAT and environmental management), authorization, monitoring, and reporting. Hence, it is an essential instrument for a safe industrial production within the EU. The regulation affects the entire chemical industry. In contrast to other activities regulated under the *IED,* the capacity of the chemical industry is not limited according to *IED's* annex 1.

Directive on industrial emissions *(IED)*[26]: Directive 2010/75/EU contains rules for the binding application of European standards of emission by defining threshold values for emissions and shall compensate inequalities among the European member states. The regulation sets essential requirements for the management of facilities and demands the application of BAT and of the best available environmental management. In addition, it contains requirements for the general control of permits and its conditions, as well as guidelines for the decommission (restoration to baseline condition) and for registration and reporting requirements in case of an accident or incident with severe health effects. Additional relevant aspects of the regulation are the substitution of hazardous substances with less harmful ones, the consideration of energy and resource efficiencies when assessing the BAT, and the measures to prevent and to reuse/recycle waste (article 11). For the chemical industry, a range of BAT reference documents summarises the current state of knowledge (e.g. organic and inorganic high volume chemistry, polymer production, organic fine chemicals industry, inorganic specialty chemicals, chlor-alkali, etc.). This state of knowledge is conformed to the technical developments on a regular basis by a continuous exchange of information among the member states, industry, and environmental and conservation organizations, the so-called Sevilla Process.

The demand for the use of BAT leads to the facilitation of sustainable economic innovations and technical progress. Furthermore, the requests for emissions reduction and the obligation to reconstruct soil and groundwater after the completion of an industrial activity contribute to the conservation and protection of biodiversity and the ecosystem.

Connected to the *IED* is the *Regulation (EC) No 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register (E-PRTR)*[27]*.* The register provides essential environmental information of industrial facilities in EU member states. Information about the amount of hazardous substances released into air, water, and soil, about movements of wastes outside the location, and about the hazardous substances in wastewater can be

[26] Directive2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

[27] Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register

retrieved for every facility. The information is given for a list of 91 important hazardous substances, which include heavy metals, pesticides, GHG, and dioxin. The public and freely available database provides the possibility to involve the public towards environmentally-relevant decision-making on a European level and to give them the access to the information regarding the release of hazardous substances and environmental pollution (transfer of knowledge).

The EU regulation is implemented on the German level via the *Federal Immission Control Act (BImSchG)* with its numerous subsidiary regulations and the *Federal Water Act (WHG)*.[28]

4.2.5 Water Protection

Besides the UNECE Water Convention, there are no general regulations for the protection of surface water and groundwater on a global level. This convention entered into force in 2003 and was changed in 2013 to a global and cooperative frame for the protection of water, which can be adapted by non-UNECE countries as well [UNECEb].

On a European level, the protection of water is primarily regulated by the *Directive 2000/60/EC establishing a framework for Community action in the field of water policy (Water Framework Directive)*[29]. Releases into water of the chemical industry have been covered by *Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC)*[30] and are subject to the *IED* since 2014 (see chapter 4.2.4).

On the national level, the *Federal Water Act (WHG)* regulates the protection of all water bodies:[31] Amongst others, the law regulates the classification of substances hazardous to waters into water hazard classes and gives instructions for their disposal. Within technical facilities, they have to be handled with such care that no

[28] "Bundes-Immissionsschutzgesetz in der Fassung der Bekanntmachung vom 17. Mai 2013 (BGBl. I S. 1274), das durch Artikel 1 des Gesetzes vom 2. Juli 2013 (BGBl. I S. 1943) geändert worden ist"

[29] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

[30] Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control

[31] "Wasserhaushaltsgesetz vom 31. Juli 2009 (BGBl. I S. 2585), das zuletzt durch Artikel 4 Absatz 76 des Gesetzes vom 7. August 2013 (BGBl. I S. 3154) geändert worden ist"

adverse effect on water bodies is to be expected. The primary purpose of the law is to ensure a sustainable water management and to conserve and protect water as a natural resource for humans and animals.

4.2.6 Waste and Risk Management

The *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal* [UBA 1989] regulates the control of transboundary transport of hazardous waste on a global level and thus contributes to the protection of human health and ecosystems. The export of hazardous or other waste into a non-contracting party as well as their import from such a party are prohibited. Among the contracting states, waste must only be exported if the importing state explicitly agrees. Transports for recycling are preferred over transports for disposal. As a guarantee, the convention defines detailed processes of notification, and the contracting states are requested to cooperate for the sake of an improvement of an environmentally-sound waste treatment. The *Basel Convention* also contributes significantly to global justice as the transport of hazardous waste into third countries with insufficient disposal or recycling infrastructure is inhibited and illegal transport is combated [UBA EURO 1989]. In order to maintain the control of the obligations, the contracting states are required to appoint and control a responsible authority.

On the EU level, waste transports across national borders are regulated under the *Regulation (EC) No 1013/2006 on shipments of waste*[32]. It implements the *Basel Convention* by also regulating export prohibitions and restrictions for waste with hazardous materials. Thematically, it is closely connected to the *PIC regulation* on chemicals and is directly applicable in Germany as well.

Regarding the management of specific wastes, for instance, the *Directive 2012/19/EU on waste electrical and electronic equipment (WEEE)*[33]*:* The *WEEE Directive* as well as the German law on the placing on the market, withdrawal, and environmentally sound disposal of eclectic and electronic disused devices (*ElektroG*), which implements the regulation on a national level, aim at establishing the environmentally friendly disposal and recovery of WEEE by extending producers’ responsibilities. The directive contains guidelines for

[32] Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste

[33] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)

classification and labelling, for free-of-charge redemption and depollution, and for information and reporting. Collection and recycling quotas provide basis for resource protection and emission reduction. The *WEEE Directive* is complemented by the *Directive 2011/65/EU restricting the use of hazardous substances in electrical and electronic equipment* (*RoHS)*[34] regulation. The *RoHS* regulates the prohibition of particular heavy metals and brominated flame retardants in electric and electronic devices in order to enhance the recyclability of WEEE. Furthermore, a frequent adaptation of the prohibitions to the current state of knowledge is planned.

In Germany, both directives are implemented by the *ElektroStoffV.*

Incident management: The *Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (Seveso)*[35] is a special European regulation. Primarily it protects employees, reduces also the hazard through massive emissions into the environment, and by this contributes in general to the protection of environment and health.

In Germany the aforementioned dangers are regulated by law in the *12th Ordinance for the Implementation of the Federal Immission Control Act (BImSchV)*.

4.2.7 Specific Legislation on Chemicals and Products

As many other aspects of CS, the following regulations are strongly connected to SC. To avoid redundancy, they are only described once. We here follow the classification and assignment as suggested by the Federal Environment Agency. In contrast to the last chapter, the following laws and activities regulate particular substances or groups of substances.

Regulation of plant protection products: The *Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market (PPP)*[36] combines aspects of sustainability and security of plant protection products. It regulates the marketing of these products as well as the prerequisites for the authorisation of

[34] Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

[35] Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances

[36] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market

active substances included in plant protection products. Moreover, it regulates approvals and permissions for plant protection products. Substances harmful to health or the environment shall be substituted, where possible, with non-chemical methods. Basically, only substances that are not classified as mutagenic, carcinogenic or toxic for reproduction are permitted. Because only plant protection products that bear no unacceptable risk for the environment are permitted, the biological diversity and ecosystems are protected. An amendment to this directive on the European level is the *Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides (SUD)*[37].

On a national level, the *Plant Protection Act (PflSchG)*[38] adds and substantiates to the PPP regulations.

Biocides Regulation: The *Regulation (EU) No 528/2012 concerning the placing on the market and use of biocidal products (BPR)*[39] addresses the marketing of biocides and contains similar provisions as the plant protection products regulation. In order to grant or extend the authorisation of a biocide product, it should not contain any substances classified as substances for substitution. However, if this is the case, the substance would be compared with the other authorised substances, the non-chemical pest control, and prevention methods to consider the risks and benefits of the product. Active substances for substitution are listed under article 10 of the directive. The biocides regulation especially focuses on the protection of the vulnerable groups among employees.

Additional regulations on a national level are included in the *ChemG*.[40]

Fertilisers Regulation: *Regulation (EC) No 2003/2003 relating to*

[37] Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides

[38] "Pflanzenschutzgesetz vom 6. Februar 2012 (BGBl. I S. 148, 1281), das zuletzt durch Artikel 4 Absatz 87 des Gesetzes vom 7. August 2013 (BGBl. I S. 3154) geändert worden ist"

[39] Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products

[40] "Chemikaliengesetz in der Fassung der Bekanntmachung vom 28. August 2013 (BGBl. I S. 3498, 3991), das zuletzt durch Artikel 1 der Verordnung vom 20. Juni 2014 (BGBl. I S. 824) geändert worden ist"

fertilisers[41] defines which fertilisers are labelled as „EC fertilisers" and thus are freely marketable within the entire EU. The designation between different sorts of fertilisers is done according to their composition, method of production, and defined nutrient contents, sorts, and solubility. Tradable fertilisers have to be labelled consistently with defined criteria. Their use must not harm human health and the environment. Furthermore, the regulation contains provisions for analysis in accordance with standardised processes and methods. Currently, an additional regulation on cadmium contents is being elaborated on the European level. This regulation shall circumvent the accumulation of cadmium in the ground. Within a planned EU directive, the threshold values for metals and organic pollutants and the requirements for epidemics hygiene shall be included as already implemented in the German regulation. Most member states as well as several associations opt for positive lists of permissible feed materials.

In Germany, the EU regulation is implemented by the *Fertilising Act (DüngG)*, the *Fertiliser Ordinance (DüMV)*, and a regulation on sampling procedures and analysis methods. In addition, good practice is regulated by the *Fertiliser Application Ordinance (DüV)* in Germany.

[41] Regulation (EC) No 2003/2003 of the European Parliament and of the Council of 13 October 2003 relating to fertilisers

DüMV[42]: The *DüMV* regulates the desired and undesired ingredients of fertilisers. They are grouped in classes and only authorised if an appropriate handling of the substance does not cause any damage to the soil fertility and to the health of humans, domestic animals, crops, and the natural system. For the production, only those substances that are of benefit for soil protection and preservation and facilitation of fertility may be used. The regulation contains also clear provisions on organic raw materials, mineral production residues, phosphates, and preparation aids; it determines threshold values and defines that the addition of foreign substances must not cause an increase of the concentration of pollutants.

The *DüV*[43] regulates good professional practice concerning the application of fertilisers, soil additives, growing medium, and plant protection products on agricultural area and the prevention of risks posed by the application of these materials. Furthermore, it contains guidelines for the prevention of pollution and of nitrates in water bodies.

Detergents, wash and cleaning agents: The *Regulation (EC) No 648/2004 on detergents (Detergents Regulation)*[44] combines EC regulations on criteria of decomposition and on labelling, takes up several voluntary agreements of industrial associations with the authorities in charge, and demands more stringent requirements for the biological decomposition of surfactants (ultimate biodegradation) as well as advanced declaration and information duties for producers.

The aim of the German *WRMG*[45] is to complete the European *regulation (EC) No. 648/2004* with additional wash and cleaning products such as surfactant-containing cosmetics (e.g. toiletry, shampoo). Similar to legislations on chemicals, this regulation emphasises the precautionary prevention of harmful emissions and the protection of biodiversity and ecosystems. Non-biodegradable surfactant may be

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[42] "Düngemittelverordnung vom 5. Dezember 2012 (BGBl. I S. 2482)"

[43] " Düngeverordnung in der Fassung der Bekanntmachung vom 27. Februar 2007 (BGBl. I S. 221), die zuletzt durch Artikel 5 Absatz 36 des Gesetzes vom 24. Februar 2012 (BGBl. I S. 212) geändert worden ist"

[44] Regulation (EC) No 648/2004 of the European Parliament and of the Council of 31 March 2004 on detergents

[45] "Wasch- und Reinigungsmittelgesetz in der Fassung der Bekanntmachung vom 17. Juli 2013 (BGBl. I S. 2538), das zuletzt durch Artikel 4 Absatz 74 des Gesetzes vom 7. August 2013 (BGBl. I S. 3154) geändert worden ist"

prohibited or restricted, which consequently leads to their substitution with less hazardous alternatives.

Pharmaceuticals: Risk management of medicine is regulated by several EU directives and guidelines, especially by the *Regulation (EC) No 726/2004 laying down Community procedures for the authorisation and supervision of medicinal products for human and veterinary use and establishing a European Medicines Agency*[46]*(EMA)*, which defines community procedures for the authorisation of pharmaceutics. The *Regulation (EC) No 470/2009 laying down Community procedures for the establishment of residue limits of pharmacologically active substances in foodstuffs of animal origin*[47] defines residue limits of pharmacologically active substances in foodstuffs of animal origin (precautionary principle). Clinic trials of pharmaceuticals are regulated on the EU level by the *Directive 2001/20/EC on the approximation of the laws, regulations and administrative provisions of the Member States relating to the implementation of good clinical practice in the conduct of clinical trials on medicinal products for human use (GCP)*[48]. It is completed by *Directive 2005/28/EC laying down principles and detailed guidelines for good clinical practice as regards investigational medicinal products for human use, as well as the requirements for authorisation of the manufacturing or importation of such products (GCP)*[49] on the principles and detailed guidelines for good clinical practice, which defines, amongst others, details on investigational medicinal products. *Implementing Regulation (EU) No 520/2012 on the performance of pharmacovigilance*

[46] Regulation (EC) No 726/2004 of the European Parliament and of the Council of 31 March 2004 laying down Community procedures for the authorisation and supervision of medicinal products for human and veterinary use and establishing a European Medicines Agency

[47] Regulation (EC) No 470/2009 of the European Parliament and of the Council of 6 May 2009 laying down Community procedures for the establishment of residue limits of pharmacologically active substances in foodstuffs of animal origin

[48] Directive 2001/20/EC of the European Parliament and of the Council of 4 April 2001 on the approximation of the laws, regulations and administrative provisions of the Member States relating to the implementation of good clinical practice in the conduct of clinical trials on medicinal products for human use

[49] Commission Directive 2005/28/EC of 8 April 2005 laying down principles and detailed guidelines for good clinical practice as regards investigational medicinal products for human use, as well as the requirements for authorisation of the manufacturing or importation of such products

activities [50] regulates the control and supervision of authorised pharmaceuticals over their entire life cycle to be able to react or counteract in the case of unacceptable risks and dangers for humans and the environment.

Veterinary medicinal products are regulated on the European level by *Directive 2001/82/EC on the Community code relating to veterinary medicinal products*[51]*.* Most of its contents are comparable to the directive on human pharmaceuticals, in particular, with regard to the manufacturing and authorisation of the medical products.

On a national level, the regulations are implemented by the *Medicinal Products Act*, which was subjected to revisions in April 2014 for the use of antibiotics in animal production [BMEL 2013].

4.2.8 Summary Evaluation of the Fulfilment of Green Economy Criteria through Activities on Chemical Safety

After the analysis of the aforementioned activities concerning the single GE criteria, the international, European, and/or national activities on CS meet especially the following GE criteria:

- ✓ effective enforcement
- ✓ transfer of knowledge
- ✓ polluter pays principle
- ✓ precautionary principle
- ✓ intergenerational justice
- ✓ international cooperation
- ✓ targeted environmental legislation
- ✓ rule of law
- ✓ working conditions
- ✓ labour rights
- ✓ substitution
- ✓ biodiversity

[50] Commission Implementing Regulation (EU) No 520/2012 of 19 June 2012 on the performance of pharmacovigilance activities provided for in Regulation (EC) No 726/2004 of the European Parliament and of the Council and Directive 2001/83/EC of the European Parliament and of the Council

[51] Directive 2001/82/EC of the European Parliament and of the Council of 6 November 2001 on the Community code relating to veterinary medicinal products

- ✓ emissions reduction
- ✓ integrated decision-making
- ✓ life cycle assessment
- ✓ fairness (environmental justice global-local)
- ✓ education

To a lesser extent, the activities are also valid for the following:

- ✓ economic innovation
- ✓ quality of life

A detailed table containing the most contributing activities for this assessment can be found in appendix IV of the German report.

4.3 Overview of Current Activities on Sustainable Chemistry

On a medium-term, the principle of SC leads to innovations with respect to the dealing with chemicals and the respective technologies, which results in additional economic stimuli. Sustainable chemicals or manufactured products thereof contain fewer hazardous substances and have a smaller harmful impact on environment and society. Therefore, SC can significantly contribute to an overall sustainable economic system.

Initiatives on resource efficiency can have direct consequences on the chemical industry, which is an important and resource-intensive industry sector.

For this reason, the following chapter lists international, European, and national activities concerning SC first (4.3.1 - 4.3.3) and complements them with general legislations and political initiatives about sustainability and resource efficiency (4.3.4 - 4.3.6).

In order to provide a quick overview of the analysed activities on the international, European, and national level in the topic area of SC, they are listed in the Table 4-3.

Table 4-3: Overview of important legislation and political activities in the topic area of SC

International	SAICM Rotterdam Convention Stockholm Convention Basel Convention Montreal Protocol Kyoto Protocol UNIDO Chemical Leasing OECD EHS and Sustainable Chemistry Network (SCN) UN Agenda 21 with Marrakech Process and Rio +20 ISO standards UNEP Resource Efficient and Cleaner Production (RECP)
European	REACH Directive 2010/75/EU on Industrial Emissions (IED) Regulation (EC) No 1005/2009 on substances that deplete the ozone layer (ODS) Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products (VOC) Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases (F-Gas) Regulation (EC) Nr. 1107/2009 on the placing of plant protection products on the market (PPP) Regulation (EU) No 528/2012 concerning the making available on the market and use of biocidal products (BPR) Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) Directive 2011/65/EU restricting the use of hazardous substances in electrical and electronic equipment (RoHS) European Growth Strategy EU 2020 for smart, sustainable and inclusive growth with Roadmap to a Resource Efficient Europe, European Resource Efficiency Platform (EREP) European Sustainable Development Network (ESDN) EU Framework Programme for Research and Innovation (Horizon 2020) Action Plan for sustainable consumption and production (SCP) Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy-related products (Ecodesign-Directive) Regulation (EC) No 1221/2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS II) EU Emissions Trading System (EU ETS) Regulation (EC) No 66/2010 on the EU Ecolabel (EU Ecolabel) Green Public Procurement (GPP) Funding programmes such as SWITCH Asia, IPEEC and sustainable industrial policy (SIP) Integrated Product Policy (IPP) Research funding programmes
National	Chemicals Climate Protection Ordinance (ChemKlimaschutzV) Ozone Layer Chemicals Ordinance (Chemikalien-OzonschichtV) UBA/OECD Workshop for Sustainable Chemistry Guide on Sustainable Chemicals UBA Project on Chemical leasing Going-Green: Chemistry National Sustainability Strategy with progress indicators German Sustainability Code (DNK) High-Tech Strategy ProgRess

	FONA The National German Sustainability Award (DNP) The National German raw materials efficiency Award GreenTech Atlas

4.3.1 International Treaties and Initiatives on Sustainable Chemistry

The most important activities in the topic area of SC are similar to those of CS:

- *SAICM*,
- *GHS*,
- *Stockholm Convention* (POPs),
- *Rotterdam Convention* (PIC) (all in chapter 4.2.1).
- *Basel Convention* (see chapter 4.2.6).
- OECD *EHS* (see chapter 4.2.1)

As all these initiatives contribute considerably to CS, they have already been described in chapter 4.2.

The *Vienna Convention for the Protection of the Ozone Layer* is an additional important international treaty on SC, which can be considered as one of the starting points for discussions on sustainability. Accompanying to the convention is the *Montreal Protocol,* which prohibits a group of broadly applied chemicals due to their newly discovered risks for the environment.

Montreal Protocol on Substances that Deplete the Ozone Layer [BMUB 2010]: The protocol to the *Vienna Convention* was created in 1987 to protect the ozone layer by a global phase-out of CFCs. By restricting the use and production of these substances, the protocol provides a timetable for this process. The protocol consequently protects the possibility of future generations to live in a healthy environment. It is the first protocol being valid in all UN countries and strongly encourages capacity building. New technologies and knowledge shall be provided to every member, and education and training programmes for developing countries are intended. The implementation of the legally binding phase-out requirements in the developing world is financially supported by a multilateral fund. In addition, the protocol demands innovative technologies and measures to recycle the controlled substances, and that require a reduced input of resources (article 9).

The 2005 *Kyoto Protocol* is the first legally binding international instrument for climate protection. It limits the emissions of GHGs.

UNIDO Chemical Leasing (ChL) [Jakl et al. 2003]: The innovative service-based business model is promoted by UNIDO and gives users and suppliers an incentive (e.g. payment is based on service instead

of quantity) to reduce their demand for chemicals by improving technologies and processes (minimising losses). Due to an intense cooperation between supplier and user, the production process is improved, fewer resources are consumed, the energy demand is reduced, and fewer chemicals are deployed. Thus, *ChL* helps saving resources and energy, reducing the environmental impact, and decreasing the risks resulting from the application of chemicals. In addition, the supplier has the responsibility for the disposal at the end of the chemicals life cycle, so a closed cycle for the chemical may be achieved. The concept is also beneficial for developing and emerging countries as *ChL* increases the transfer of knowledge concerning proper handling and use.

The approach is an example of a political initiative leading to the voluntary conversions of companies towards a service-oriented business system through market forces. This business model supports the idea of a GE. Currently, *ChL* is being tested worldwide in several pilot projects and is promoted by information events and awards. However, so far, no mainstream is established.

OECD Sustainable Chemistry Network (SCN): The *SCN* is a part of the OECD *EHS* programme and primarily a platform for information exchange and promotion of cooperation concerning SC. The *SCN* specifically prepares case studies and guidelines of particular topics to simplify information exchange, assess new developments, and develop incentives for SC (see chapter 4.2.1).

4.3.2 European Regulations on Sustainable Chemistry

The most important regulating body for a SC in Europe is *REACH*, which combines safety issues with aspects of sustainability (requirement of substitution, emissions reduction, etc.).

For systematic reasons, the key aspects of *REACH* have been discussed together with the *CLP* regulation and the *IED* in chapter 4.2.4.

Some additional specific aspects on sustainability are mentioned here:

REACH: The regulation promotes sustainability in the chemical industry especially by:

1. communicating information on hazard characteristics and save use of substances along the entire value-added chain,
2. ensuring that chemicals are only produced and used if their use is save,
3. demanding a general requirement for substitution, and
4. controlling the use of substances of very high concern (they are subject to prior authorisation and may only be applied under

controlled conditions if no less hazardous alternatives exist and the economic impacts of a prohibition outperform the risks for health and environment).

REACH follows a stepwise approach (priority of greatest risk) with an increasing intensification of the requirements for both the recorded production/import quantities and the hazards of the substances. Substances of very high concern, such as carcinogenic, mutagenic or toxic to reproduction (CMR) and persistent, bioaccumulative, and toxic (PBT) substances, require authorisation under *REACH*. By facilitating the information exchange along the value-added chain, which, for the first time, leads to a systematic analysis of the life cycle of chemicals, *REACH* also promotes the identification of the greatest risks and the development of solutions for an efficient and environmentally-friendly application and therefore fosters sustainability (for aspects of safety, see also chapter 4.2.2).

Further legislations have already been discussed under CS, but they have a strong connection to sustainability, for instance, the *WEEE Directive* (see chapter 4.2.6), as well as the regulations on single groups of substances and products such as

1. pesticides, biocides, fertilisers
2. VOC
3. *RoHS* to restrict hazardous chemicals in WEEE

as well as numerous laws on consumer products (see chapter 4.2.7 for all of them).

IED (see chapter 4.2.4): Within the meaning of a SC, the regulation especially demands in its guidelines on BAT and best environmental practice (BEP) the following:

1. the use of low-waste technology
2. the use of less hazardous substances
3. the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate
4. comparable processes, facilities or methods of operation which have been tried with success on an industrial scale
5. technological advances and changes in scientific knowledge and understanding
6. documentation of nature, effects, and amount of emissions
7. the introduction of best available technologies
8. minimising the consumption of raw materials (including water)

as well as energy efficiency

9. the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it
10. the prevention of accidents and their consequences for the environment [UBA 2012]

The *Regulation (EC) No 1005/2009 on substances that deplete the ozone layer (ODS)*[52]: The regulation implements the *Montreal Protocol* in the EU. The requirements concerning emissions reduction and substitution are comparable between both regulations.

VOC regulation: The *Directive 2004/42/CE on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products* contains rules for the restriction of emissions of VOCs from organic solvents in certain paints, varnishes and vehicle refinishing products by setting threshold values and developing water soluble alternatives.

F-Gas-Regulation: The *Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases*[53] also implements the *Kyoto Protocol*. It regulates the reduction of emissions, the use, reuse, and destruction of particular fluorinated GHGs as well as the labelling and disposal of products and goods containing these gases. Furthermore, the regulation contains prohibitions for the use and marketing and demands the development of environmentally friendly technologies. Every producer, importer, and exporter of fluorinated GHGs is required to report to the commission and the national authority to enable the authorities to control the implementation of the guidelines.

4.3.3 German Activities on Sustainable Chemistry

On a national level, all aforementioned EU legislations and regulations are generally valid and implemented by national laws.

In Germany, the *Chemicals Climate Protection Ordinance*[54] *(ChemKlimaschutzV)* is applied in addition to the European *F-Gas*

[52] Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer (recast)

[53] Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases

[54] "Chemikalien-Klimaschutzverordnung vom 2. Juli 2008 (BGBl. I S. 1139), die zuletzt durch Artikel 5 Absatz 42 des Gesetzes vom 24. Februar 2012 (BGBl. I S. 212) geändert worden ist"

Regulation. It especially defines requirements regarding leakage (threshold values) of fixed installations, obligations to check mobile facilities, reclaiming and recycling requirements, obligations for recording and storing, and rules for labelling.

The national implementation of the Kyoto Protocol is achieved by the *Ozone Layer Chemicals Order (Chemikalien-OzonschichtV)*.

Moreover, Germany is engaged in international and European initiatives like e.g. *SAICM* and OECD. And e.g. UBA organises several research projects and workshops about sustainability. Concerning SC, the following activities are especially important:

UBA/OECD workshop on sustainable chemistry [UBA 2009a]: The workshop took place in 2004 and worked on the improvement of the SC concept and passed specific criteria such as

- qualitative development: use of harmless substances
- if the former is not possible: development of substances involving a lower risk for humans and the environment and manufacture of long-life products in a resource-saving manner;
- quantitative development: reduction of the consumption of natural resources, which should be renewable wherever possible; avoidance or minimization of emission or introduction of chemicals or pollutants into the environment; such measures will help to save costs;
- comprehensive life cycle assessment: analysis of raw material production, manufacture, processing, use and disposal of chemicals and discarded products in order to reduce the consumption of resources and energy and to avoid the use of dangerous substances;
- action instead of reaction: avoidance, already implemented at the stage of development and prior to marketing, of chemicals that endanger the environment and human health during their life cycle, and make excessive use of the environment as a source or sink; reduction of damage costs and the associated economic risks for enterprises and remediation costs to be covered by the state;
- economic innovation: sustainable chemicals, products, and production methods produce confidence in industrial users, private consumers, and customers from the public sector and thus result in competitive advantages.

The outcomes of the workshop were further developed in the 2012 *Agenda Process Green Economy* (see chapter 4.4.3).

Guide on Sustainable Chemicals [Reihlen et at. 2010]: The report „Entwicklung von Kriterien und Methoden für nachhaltige Chemie“

[Bunke et al. 2010] strongly emphasises that sustainable chemicals have to be introduced purposefully into trade and value-added chains. Although a number of single measures for sustainability do already exist among enterprises in the chemical sector, no concept is available that helps companies to systematically implement sustainable chemistry in their daily business so far. There is a strong demand for substance-specific information on chemicals, and the report can be regarded as a detailed guideline in this context. Sustainability criteria, which can be differentiated into substance and use-related criteria, were described. They are complemented by 10 golden rules for the selection of sustainable chemicals.

Besides substance-related hazards, the guideline also considers resource depletion, CO_2 emissions, and the social responsibility of companies. Specific attention during the development of the criteria was given to the information which can be provided by the companies themselves and the requirements their suppliers have to fulfil. According to the guideline, the most important criteria for testing the sustainability of chemicals are the physicochemical properties, human and environmental toxicity, mobility, the origin of (raw) materials, the GHG potential of (raw) material supply, and the resource demand that is connected to the production of the (raw) material.

The proper evaluation of every criterion is done in a table that enables the assessment of the sustainability of a substance according to special indicators (green, yellow, red, and white). When classified as yellow or red, the substances and compounds have to be analysed in an additional second step for the sake of the exposure assessment regarding the following criteria:

1. the emission potential of the use of the substance
2. the groups of users of the substance
3. the used amounts of the substance
4. the waste phase of the substance
5. the substitutability of the substance
6. the potential benefits of the substance
7. the potential for innovations

UBA Projects on ChL [UBA 2009b]: Amongst others, these projects developed sustainability criteria for *ChL*, which are now globally accepted and applied. Furthermore, implementations of *ChL* in Germany are promoted, and their experiences are exchanged through national and international advisory boards.

Going-Green- Chemicals [Lahl & Zeschmar-Lahl 2011]: According to the publications by Prof. Lahl, the following seven topics include

important options to foster resource efficiency in the German chemical industry.

a) Resource efficiency: A common methodology for determining the actual resource efficiency of a produced chemical is needed in order to be transparent. This information may influence purchase decisions in the supply chain. In addition, financial incentives have to be provided when raw materials are utilised efficiently.

b) Chemical safety: The report identifies a lack of producer's and consumer's knowledge with respect to the hazards of particular substances and potential alternatives and requests to improve the knowledge about the latter especially among product developers and consumers. A public European database that provides information on substitutes and their development is mentioned as an instrument for enhanced transparency. Moreover, the competent authorities would have to complete the lists on hazardous chemical substances and compile a list on less-hazardous or non-hazardous chemical substances. Another possibility for more substitution is a Household Products Database (HPDB) (see chapter 4.3.7) that informs consumers about the composition of products and can be used to support purchasing decisions.

c) Raw material supply or 'feedstock change': The report identifies a lack of knowledge about renewable alternatives for the major chemical feedstock (petroleum). As the abandonment of petroleum implies climatic benefits, the report prompts policy makers to alter public subsidies, which currently discriminate biomass as an industrial feedstock and favours the use of fossil fuels. Governmental support shall further promote the cascade use of biomass as this constitutes the only efficient usage. In addition, binding sustainability requests for biomass are postulated according to the model of the renewable energy directive.

d) Climate protection: Since the process emissions of the chemical industry increased during the last years despite a reduction of emissions per product unit and the European emission permits will not contribute significantly to the energy efficiency of German chemical plants, the report requests to set the European GHG emission reductions target to 30% without imposing conditions. This would tighten the emissions trading system and result in the required savings in the chemical industry.

e) New priorities in business development: The report asserts that the differing business developments of the various

political levels (EU, federal government, federal states, municipalities) do not lead to a consistent orientation on resource efficiency goals and competitiveness. Thus, it requests that business developments are closely aligned to these goals and mentions the *business model ChL* as a successful example.

f) Research and development (innovation spaces): The report especially considers the core of chemical synthesis to have a demand and need for progress in terms of resource efficiency. It requests a targeted facilitation through research and development. All stakeholders have to be involved in order to systematically foster innovations and set target areas. It is a central task to create a scope for innovation whose research concentrates on resource efficiency and its strategic importance. As examples for important research and innovation areas, the report mentions the financial participation of the economy in the development of innovations with gradual planning leading up to full development, arbitration systems, and sanctioning mechanisms. According to the authors, the following fields of research provide the highest potential for innovation: white biotechnology, nanotechnology, CO_2 as a chemical input, solar reaction energy, efficient synthesis routes, and avoidance of hazardous and toxic substances.

g) New plastics (packaging): Within this paragraph, the report discusses the need for (quickly) degradable polymers as plastics are currently accumulating in the environment, which could cause the death of many species if they swallow the plastic. Eventually, the plastic accumulates as harmful micro particles in the environment. Thus, the report requests a Europewide ban of plastic packaging that is not degradable in the environment within a few years. However, this does not exclude the ongoing promotion of chemical plastic recycling.

The research project „Assistenz bei der Evaluierung von Strategien zur Chemikaliensicherheit und Weiterentwicklung einer Nachhaltigen Chemie in Deutschland“[Giegrich et al. 2011]: Within this 2011 research project, the absence of a clear outline of the term sustainability is regarded a major problem. The report recommends prioritising sustainability targets in order to better evaluate them and emphasises the necessity of a standard definition of sustainable development. According to the authors, it is not only about the degree of sustainability of a product or company but also about its contribution to a society’s sustainable development.

Within this context, the report developed a set of criteria for the chemical industry on the basis of the criteria of the German and European sustainability strategy. Here, different criteria for the levels companies, locations/production, chemicals, and products were developed. According to the recommendations of the SC guideline, product-related indicators shall consider an evaluation of the functional benefit (benefit of the product, contribution of the function or property to economic welfare, contribution of the product to this function).

Besides these indicators, the authors regard broad application of audits, sustainability reports, labels, databases, and a transparent communication in the supply chain as important contributions for sustainability development. In this context, it has to be analysed which aspects of the *Global Reporting Initiative (GRI)* are applicable for SC.

Considering renewable resources, the report regards the definition of sustainability of renewable resources as an important topic for chemical industry. The authors state that the example of sustainability requirements for bioenergy shows possible transformations of requirements to biobased substances. Further possibilities for transformation arise from the developed assessment criteria for abiotic resources and conventional chemicals. However, it has to be tested whether this can serve a sustainability perspective. Furthermore, this requires an analysis of the core issues of abiotic resource extraction and sustainability goals.

As examples of optimised communication as a possibility of improved control of sustainable consumption, the report lists the *Green Products Registry* and the *Household Products Database (HPDB)* of the USA's National Library of Medicine [NLM 2013] (see chapter 4.3.7).

4.3.4 International Treaties and Initiatives on Sustainability and Resource Efficiency

Agenda 21 [UNDESAa]: The major international initiative on sustainability is the Agenda 21, which was agreed upon on the United Nations Conference on Environment and Development, (UNCED) in Rio de Janeiro in 1992. The agenda represents a guidance paper for sustainable development and the global action programme of the 21st century concerning development and environmental politics.

Chapter 19, section 2, addresses the environmentally sound application of toxic chemicals. The particular priorities are the expansion and acceleration of the international assessment of risks posed by chemicals, the harmonisation of classification and labelling of chemicals (see also *SAICM* and *GHS*), the exchange of information about toxic chemicals and chemical risks, the establishment of programmes for risk reduction and of better

prerequisites for the management of hazardous substances, and the measures to prevent illegal international trade with toxic and hazardous substances.

Intensification of international effort and close cooperation are requested as they are decisive factors for a successful implementation. This focuses mainly on the cooperation between UNEP, ILO, and WHO within the *CSIPCS*. The *Human Health Risk Assessment Toolkit* (WHO, UNEP, ILO) for chemical hazards [WHO 2014j] with its guidelines for evaluating threats to health due to chemical risks is a result of this cooperation.

Article 20, section 2, is concerned with the environmentally sound disposal of hazardous wastes, including the prevention of illegal international shipment of such waste. The requirements include the prevention of dangerous waste by reduction and recycling (see *Basel Convention* and EU regulation on transboundary waste transport).

Marrakech Process (2003): In order to implement *Agenda 21* and the *Johannesburg Plan of Implementation (JPOI)* [UNDESA & UNEP 2010], the UNEP and the United Nations Department of Economic and Social Affairs (UN DESA) instigated and financed programmes to include sustainable principles of consumption and production, especially emphasised in developing and transition countries. Key aspects are the introduction of producer responsibility and the development of tools, instruments, and the measures for indicators and life cycle considerations of impact assessments of consumption and production [UN 2008]. Other important issues of the programme are a stronger decoupling between economic growth and resource and raw material input by using the materials in a sustainable manner and considering resource management in political decision-making processes (integrated decision-making). The market shall be supported in a way that more sustainable products for sustainable consumption are offered and that they subsequently contribute to new economic activities and green jobs within the boundaries of ecosystems. Furthermore, the political incentives for social and technical innovations, which foster a more sustainable way of life, are emphasised in the programme. The requested measures are not restricted to the economic sector, but consumers shall be better educated and informed about sustainable living [UN 2008].

Rio +20, United Nations Conference on Sustainable Development (UNCSD) [UNDESAb]: Twenty years after Johannesburg, the conference in Rio de Janeiro in 2012 constituted the third international conference on sustainable development and focused on the connection of economic and ecological goals of the world (see chapter 4.2.1). The main result of *Rio+20* was the document “The future we want,” in which the states again commit themselves to achieve an appropriate

management of chemicals and hazardous wastes along their life cycles until 2020 (see *Agenda 21*). The development of new sustainable development goals (SDG) with a strong consideration of the environment is listed as a target in the document. Further results are the ideas to convert UNEP into a global environment agency and to find alternatives for indicators of welfare, which must include social and environmental aspects and must monetarise ecosystem services. In recognition for the necessity of profound changes in production and consumption behaviour, proposals for producer responsibility were discussed (shift of tax burden). Further topics included the protection of marine resources (management plans) and the expiration of subsidies for fossil fuels (self-commitment of the member states).

ISO standards: Although standards are not legally binding, they often set a common basis. Adhering to these standards can be occasionally certified. These certificates are broadly acknowledged in the practice and are sometimes required for the collaborations of industrial enterprises. Considering sustainability, the international standard *ISO 14001* is essential for environmental management systems [ISO]. In order to be certified under *ISO 14001*, the following requirements have to be fulfilled: the establishment of an environmental management system, the documentation of the system (targets, scope, main elements and their interaction as well as references to corresponding documents), the internal and external audits, the determination of the environmental performance (measurable results), and continuous improvement of the environmental management [Springer]. Almost all aspects of the *ISO 14001* standard are also included in the *EMAS* regulation although this provides more specific measures of environmental management [UGA 2013] (see chapter 4.3.5).

Resource Efficient and Cleaner Production (RECP) [UNEPc]: UNEP and UNIDO cooperate with enterprises, governments, and organisations in order to implement and introduce resource-efficient and clean production. The programme aims to improve the technical level of companies to the level of the BAT and to reduce the input of chemicals. Through the improvements in the handling of chemicals and a substitution of hazardous substances with less hazardous ones, the risks for humans and the environment can be reduced [UNIDO]. In order to implement this programme, UNIDO cooperates with the members of the global *RECPnet* network. The key factors of the cooperation are based upon the information exchange, the awareness raising for the necessary measures, the training of experts, and the transfer of knowledge about suitable environment technologies.

4.3.5 European Programmes on Sustainability and Resource Efficiency

EU 2020 [EU COM 2014d]: The strategy aims at an intelligent, sustainable, and inclusive economy. Intelligent refers to higher expenses for education and a stronger financial support of research and development. Sustainable means a reduction of GHG emissions, an increasing share of renewable energies, and the enhancement of energy efficiency by maintaining competitiveness at the same time. Inclusive refers to an increase of employment and the abatement of poverty and social exclusion.

The core objectives (and progress indicators) are the following [EU COM 2014e]:

1. employment: 75% of the 20 to 64 age group shall be employed
2. research and development (R&D): 3% of EU's GDP shall be dedicated to R&D
3. climate change and sustainable energy management: reduction of GHG emissions by 20% (or even 30% if the necessary prerequisites are given) compared to 1990
4. increase of the share of renewable energies to 20%
5. enhancement of energy efficiency by 20%
6. education: reducing the number of early school dropouts to less than 10%; increasing the percentage of the age group 30 to 34 holding a degree of higher education to at least 40%
7. abatement of poverty and social exclusion: reducing the number of people affected by or at risk of poverty and social exclusion by at least 20 million

The Roadmap to a Resource Efficient Europe (2011) [EU COM 2014f] is the implementation of the flagship initiative for a resource-efficient Europe and thus a part of the *Europe 2020* strategy. Its aim is to increase the economic performance by simultaneously decreasing the demand for resources. Hence, it supports the amplification of resource productivity and the decoupling of economic growth from resources and environmental impacts. Concerning the natural capital and ecosystem services, this roadmap set their respective determination of value and the protection of biodiversity and ecosystem services as their milestones until 2020 [EU COM 2011a]. The major targets are the following:

- strict requirements for Green Public Procurement (GPP) for products with significant ecological impacts
- development of an environmental footprint for goods, products, services, and companies (life cycle considerations, circular economy)

- definition of requirements for resource efficiency within the frame of the Ecodesign Directive (e.g. recyclability/usability/reusability, recycled material, durability) and extension of the scope of the Ecodesign Directive to products not relevant to energy use
- improved understanding of consumption behaviour and improved information on the ecological footprints of products (prevention of application of misleading declarations, enhancing label systems)
- support of agencies (networks, exchange of exemplary processes) that are concerned with resource efficiency for SMEs

European Resource Efficiency Platform (EREP): The platform, which is used for the implementation of the flagship initiative, demands in its *Manifesto for a Resource-Efficient Europe* amongst others the political integration of resource scarcity and vulnerability at the national, European, and international levels [EU COM 2011b]. Additional aspects are the improved use of waste as a secondary resource, the facilitation of research and innovation, and the abolishment of subsidies that are harmful for the environment.

The European Sustainable Development Network (ESDN) is a network for the implementation of EU 2020. The aim is to exchange experiences and knowledge on the most important aspects of the sustainability process at the different levels (European, national, regional) [ESDN]. For instance, the network addresses the development and implementation of strategies as well as the horizontal and vertical political integration.

EU Sustainable Consumption and Production (SCP) and Sustainable Industrial Policy Action Plan (SIP) [EU COM 2013a]: The 2008 action plan emphasises energy savings, energy and resource efficiency, promotion of innovation, and the related competitiveness of the industry. Sustainable consumption and production shall be strengthened by different measures. Within the plan, the following legal regulations have been developed or improved in particular:

- *EC Environmental Management and Audit Scheme (EMAS II)* [UGA]
- *EU ETS* [EU COM 2014g]
- *Ecodesign Directive* [EU COM 2014h]
- *Ecolabel Regulation*[55]

[55] Regulation (EC) No 1980/2000 of the European Parliament and of the Council of 17 July 2000 on a revised Community eco-label award scheme

- *GPP* [EU COM 2014i]
- *IED*

In addition, international programmes such as the EU *SWITCH-Asia programme* for sustainable consumption and production and the *International Partnership for Energy Efficiency Cooperation (IPEEC)* are funded. [BMZ 2014]

EMAS II [UGA]: The objective of EMAS II is to create incentives for the development of sustainable products. Product declarations validated by *EMAS* ("validated information") can be used by companies as a quality label. The core indicators address the topics of energy efficiency, material efficiency, water, waste, biological diversity, and emissions (including GHG).

EU ETS [EU COM 2014g]: This is the EU's most important instrument for climate protection. The market-based instrument of emissions trading shall help to protect the climate. As a Europe-wide system, it improves the cooperation between member states and companies to reduce emissions. GHG emissions of installations subject to compulsory emissions trading are limited to a total amount, the so-called cap, and are distributed as tradable allowances. The *EU ETS* currently records the CO_2 emissions of the companies in the energy sector and in the energy-intensive industry. Additional issues shall be addressed in the future. Besides the allocation of emissions rights, the *EU ETS* is concerned with the supervision and determination of CO_2 emissions as well as the annual accounting (emissions reporting, creation of new figures). Companies with a surplus of certificates (fewer emissions than permitted) can sell those certificates. Enterprises with excessive CO_2 emissions have to purchase emission permissions on the market (producer responsibility). Prices of the certificates are defined by supply and demand. Between 2013 and 2020, ETS is subject to a broad harmonisation. Until 2020, GHG emissions shall be reduced stepwise by 21 % compared to 2005. With the annual shortage of certificates and thus permissible CO_2 emissions, a continuous reduction of GHGs is achieved. This in turn gives incentives to the participating companies to improve technologies and processes (sustainable innovation).

GPP: Within the frame of sustainable supply chain management, sustainability standards for cleaning products, furniture, floor and wall coverings, insulating material, and sanitary taps have been created on a European level since 2008 and shall be considered by contracting authorities as a model paradigm. Furthermore, criteria for windows, doors, and wooden floorings are planned.

Integrated Product Policy (IPP) [EU COM 2014j]: The concept shall help to consider the entire life cycles, emissions, and waste

reduction already during the production of a good. For this purpose, political instruments, such as standardisation, environmental management, ecolabelling and ecodesign, are applied, and guidelines for the assessment of great potentials of improvement are developed.

European research promotion on innovation: On the European level, the main programme for research funding and support is the *FP*, which has already been introduced in chapter 4.1.2. *INNOVA* [EU COM 2013b] is introduced here as an example of funding for innovations within SMEs. Within INNOVA, the *BIOCHEM project* has been supported, which shall strengthen the use of bio-based products from renewable resources. Another research concept is the *European Cooperation in Science and Technology (COST)*, which promotes, in addition to the *FPs*, innovative developments in the domain of Chemistry, Molecular Sciences, and Technology.

4.3.6 German Regulations and Activities on Sustainability and Resource Efficiency

National Sustainability Strategy (2002) [BPA 2014]: The guidelines of this strategy are intergenerational justice, social cohesion, and international responsibility. Therefore, the strategy defined indicators with medium- and long-term specifications.[56] The programme is based on consultations with societal groups and on suggestions from the *Council for Sustainable Development*, which contributes to the implementation of the national sustainability strategy, defines areas that require action, and raises public awareness for sustainability. To implement the *EU 2020* strategy, the German *National Reform Programme (NRP)* of April 2011 declared the following objectives regarding criteria of sustainability and progress:

1. employment: 77% of the age group 20 to 64 shall be employed
2. R&D: 3% of EU’s GDP shall be dedicated to R&D
3. climate change and sustainable energy management: reduction of GHG emissions by 14% compared to 1990
4. increase of the share of renewable energies to 18%
5. enhancement of energy efficiency/reduction of energy consumption by 33.3 mt of crude oil equivalents

[56] Ressourcenschonung, Energieverbrauch, Rohstoffproduktivität), Klimaschutz, erneuerbare Energien, Flächen, Artenvielfalt, Staatsverschuldung Wirtschaftsvorsorge, Innovation, Bildung, Wirtschaftliche Leistungsfähigkeit(BIP), Mobilität, Landwirtschaft, Luftqualität, Gesundheit/Ernährung, Kriminalität, Beschäftigung, Familienperspektiven, Gleichstellung und Integration, Entwicklungszusammenarbeit, Märkte.

6. education: reducing the number of early school dropouts to less than 10%; increasing the percentage of those in the age group 30 to 34 holding a degree to at least 42%
7. abatement of poverty and social exclusion: reducing the number of people affected by or at risk of poverty and social exclusion (long-term unemployed) to 330,000

According to the requirements, non-renewable resources must only be used if their function cannot be substituted by other materials.

German Sustainability Code (DNK) [GIZa]: The *DNK* (2012) is a database instrument that makes company's achievements in sustainability more transparent and comparable. The code is suitable for enterprises of all sizes and legal forms and shall particularly support SMEs in their sustainability efforts. To fulfil the code, the sustainability reports have to be in accordance with the highest report standards of *GRI* (A+) or of the European Federation of Financial Analysts Societies (EFFAS) (level III). The code states that "The German Council for Sustainable Development recommends that the Federal Government promulgate the German Sustainability Code at European and global level, citing it as an important contribution to the future prospects of a green economy. It recommends that the Federal Government especially introduce the Sustainability Code into the EU discussion on the reporting of the non-financial key performance indicators of companies and on corporate social responsibility". Furthermore, it states "The Council will approach the World Bank, the International Finance Corporation, the Asian Development Bank, UN PRI […]". Thus, the aim is a targeted integration of financial institutes towards the financial promotion of sustainability. By now, the Sparkassengruppe is the first partner of the financial sector involved in the Sustainability Code (see also chapter 5.7).

High-Tech Strategy [BMBF 2012]: Since 2006, this strategy has combined promotions of innovations and key technologies across numerous topics. Core issues of the strategy are the implementation of green services and innovative technologies regarding resource efficiency and the support of renewable resource use. Dangerous substances and materials shall be supported where possible. Moreover, the strategy promotes sustainable material cycles and a circular economy, the creation of age-appropriate and safe workplaces, and more investments into education and training of young researchers.

ProgRess [BMUB 2011]: The national programme on resource efficiency is one of the first comprehensive and strategic concepts to foster resource efficiency in Europe. Its focus lies on abiotic, non-energetic, and biotic resources used as materials and on minimising

the negative impacts on the environment from the production of the raw materials and the subsequent processing along the entire value-added chain.

The programme is especially based on market incentives, information, consultation, education, research, and innovation as well as on strengthening voluntary measures and initiatives in economy and society. This includes the strengthening of efficiency consultation for SMEs, the promotion of environmental management systems (*ISO, EMAS*), a greater consideration of resources in standardisation processes, a stronger orientation of public procurement on the use of resource efficient products and services, the amplification of voluntary product labels and certification systems, the extension of a circular flow economy, and the strengthening of technology and knowledge transfer into developing and emerging countries.

Regarding sustainable chemistry, the focus of *ProgRess* lies on an increased use of renewable raw materials (see *ProgRess* example 7) and on improved materials recycling of plastics waste (see *ProgRess* material flow 4).

Furthermore, *ProgRess* aims at reducing environmental burdens like GHG emissions, destruction of ecosystems, loss of biodiversity, and pollution of soil, water, and air that are associated with raw materials extraction. Consequently, the programme wants to consider raw material equivalents of imports, domestic resource demands per capita, unused material extractions, and the contribution of recycling as sustainability criteria.

Sustainability networks and agencies

Amongst others, German sustainability agencies include:

- *German Agency for Material Efficiency (DEMEA):* The agency is responsible for the provision of information on material efficiency and also for raising awareness among the general public for a more efficient treatment of raw materials especially in SMEs. Therefore, DEMA developed an online tool for self-control of companies [BMWi] and conducted numerous consultations. It focuses on the manufacturing industry, but companies of the chemical sector also belong to the activities.
- *German Energy Agency (DENA):* The agency, founded in 2000, is responsible for energy efficiency, renewable energies, and smart energy systems. It promotes the development of technologies, informs the public about efficiency potentials, and rewards particular achievements.
- *The centre for resource efficiency of the Association of German Engineers (VDI-ZRE)* [VDI 2014a]: Since 2009, the centre has been responsible for the development of regulations and

guidelines on resource efficiency (VDI guidelines), for informative literature, and for checking the overall resource demand by especially focusing on SMEs. The determination of efficiency potentials in the chemical industry sector among others is another aspect of the centre’s tasks.

- *German Mineral Resources Agency (DERA)* [BGR]: The agency is under the responsibility of the Federal Ministry of Economic Affairs and Technology (BMWT), now Federal Ministry of Economic Affairs and Energy (BMWi), and supports the German raw materials processing industry through funding programmes for the diversification of raw materials supply, exploration and mining activities, and concession acquisitions and shareholdings.

Network Resource Efficiency [VDI 2012]: Since 2007, the network has been acting as a platform for examples of best practice for companies.

Resources Commission at the Federal Environment Agency (KRU) [UBA 2013b]: The KRU was launched in 2013 as an advisory board to the UBA to support resource protection and sustainable use of natural resources, which are the key elements of viable societies in the future.

German Society for International Cooperation (GIZ): The GIZ contributes to a safe and sustainable chemicals management by developing guidelines and training material and by promoting pilot projects and exercise programmes on CS and SC in developing and transition countries. GIZ supports its partner countries with respect to the improvement of their chemicals management and gives advice for the implementation of the requirements of international and national regulations. [Adelmann 2001, GIZb]

FONA research framework programme of the BMBF: FONA is the key German instrument for sustainability and innovation research. The four major areas of research [BMBF] are i) developing strategies for social action geared to sustainability with the aim of meeting basic needs while minimizing the risks for the long-term stability of nature and society, ii) sustainable orientation of globalised economies and production systems while protecting the German economy’s competitiveness on the long term, iii) considering an improvement of the quality of life and a protection of natural, social, and economic fundamentals during regional planning and spatial development, and iv) sustainable resource management. A central funding aspect of *FONA* is the improvement of resource efficiency and innovations within SMEs (project “KMU-innovativ”). Since 2008, another area of interest is in the possibilities of sustainable consumption by specifically involving contributors such

as consumers, producers, and retailers (“Vom Wissen zum Handeln – Neue Wege zum nachhaltigen Konsum“). The promotion of sustainable consumption goes along with the sustainable production of goods [BMBF 2009].

Additional German research programmes include

- BMUB’s *Environment Innovation Programme* (examples of „best practice“),
- German Federal Foundation for the Environment’s (DBU) *Technology Promotion*, and
- BMBF’s funding priorities *Innovative Technologies for resource efficiency r2 and r3*.

Other examples include

- BMWi’s *The Central Innovation Programme for Small and Medium Enterprises (ZIM)*,
- BMEL’s funding programme *Renewable Raw Materials*, and
- the *Master Plan for Environmental Technologies.*

Important governmental awards for the promotion of material and resource efficiency are the following:

The National German Sustainability Award (DNP): The *DNP* is the national award for commitment in the field of sustainability of companies and municipalities in Germany. The responsible agency is the Foundation “Stiftung Deutscher Nachhaltigkeitspreis e.V.” in cooperation with the federal government, associations of local authorities, business federations, civil society organisations, and research institutes. Award criteria include an outstanding combination of economic success with social responsibility and environmental protection. The research awards *Nachhaltige Entwicklungen* (*Sustainable Developments* by BMBF) and *Blauer Engel-Preis* (*Blue Angel price* by BMUB und UBA) are presented by the federal government within the DNP frame. Since 2013, the special prize *Ressourceneffizienz (resource efficiency)* has honoured companies that have successfully established measures for resource saving and raw material and energy efficiency in their production and value-added chain. The prize is awarded annually within the framework of the German Sustainability Conference, a globally leading sustainability congress. [SDNP]

German Award for raw materials efficiency: The BMWi rewards excellent examples of resource efficient products, processes or services as well as application-oriented research findings with this prize. Under the leadership of DERA, four companies and one research institute are awarded with 10,000 Euro.

German Industry Innovation Award [FAZ]: With the sponsorships of BMBF and BMWi, the award has honoured outstanding scientific, technical, corporate, and intellectual innovations for the last 33 years.

In order to communicate successful examples of implementations, the BMUB published the following:

GE in practice: Success Stories in German Companies [BMUB 2013]: The brochure lists examples of the implementations of a GE in German enterprises.

GreenTech Atlas [BMUB 2012b]: The atlas on environmental technologies gives an overview of the role of German companies of the world market for environmental technologies and resource efficiency. It contains an analysis of the markets of environmental technologies and a database of green tech enterprises. The *GreenTech Atlas 3.9* identifies six leading markets for environmental technologies: energy efficiency, sustainable water management, environmentally sound energy and energy storage, sustainable transport, raw materials and resource efficiency, and circular economy.

4.3.7 Sustainable Chemistry-Related Initiatives of Other Industrialised Countries

US Environmental Protection Agency (EPA): Since the 1990s, the EPA has been concerned with the harmful emissions into the environment. To foster green chemistry, EPA has developed a variety of different initiatives and projects:

Pollution Prevention Strategy (P2) [EPA 2010a]: The strategy aims at the development of activities to prevent emissions at the place of origin. The outcomes of the P2 were the creation of several additional programmes, which also focus on the protection of the environment. An example is the *Green Chemistry Program,* which shall implement the introduction of more sustainable chemicals and chemical processes. An activity for accelerated implementation of green chemistry is the *Green Chemistry Education Programm*. EPA supports the development of new materials and novel methods of training among other topics. The online *Greener Products Portal* provides specific information on EPA programmes that promote green products to consumers. Furthermore, general information related to EPA and other references on green products are given.

EPA executes the *Environmental Preferable Purchasing (EPP) Programme*, which corresponds to the European *GPP* (see chapter 4.3.5). The guidelines included in the documents offer criteria for selection. Similar to the European programme, the concept covers the topics of construction materials, carpets, cleaning agents, electronics, food services, logistics, office material, conferences,

and paper. [EPA 2010b]

HPDB [NLM 2013]: The product database links information of over 13,000 products of different brands with information form material safety data sheets (MSDSs). *HPDB* enables scientists and consumers to search for products by their chemical ingredients and to receive comprehensive information about the product such as the particular chemicals that a product contains and which effects it has on health.

4.3.8 Summary Evaluation of the Fulfilment of Green Economy Criteria through Activities on Sustainable Chemistry

This chapter summarises how far the GE criteria, which have been defined for this project, are implemented by political activities in the topic area of SC. A detailed table containing the most contributing activities for each criterion can be found in appendix V of the German report.

For many of the essential political activities regarding SC and CS, a clear separation is difficult as safety and sustainability aspects relate to each other or include resource efficiency as well as climate protection as positive impacts on environment and health. Thus, they were considered in the assessment of both topic areas. This is particularly the case for the following activities:

- *SAICM* and *REACH*
- *GHS* and *CLP regulations*
- *Rotterdam* and *Stockholm Conventions* with *PIC* and *POPs regulations*
- *Basel Convention* with the directive on cross-border waste transports
- OECD programmes *CSB* and *EHS*, with developments of test guidelines (good laboratory practice), assessment (*QSAR, CoCAP-HPV*) and chemicals management (*Sustainable Chemicals Platform, PRTR, SCN*)
- *IED* and *BImSchG*
- *WEEE Directive* and *RoHS* guideline
- EU pesticides, biocides, fertilisers, and detergents regulations as well as the respective German legislation
- *Vienna Convention* with *Montreal Protocol*, *F-Gas regulation* and *ChemKlimaschutzG*
- *Kyoto Protocol* and *VOC regulation* and *ozone regulation*

In addition, the following initiatives on sustainability and resource efficiency were analysed in context with SC although they do not exclusively refer to chemicals:

- UNEP’s support initiative *Flexible Framework*
- *ChL*
- *guideline SC*
- *Agenda 21* with *Rio+20* and *Marrakech Process*
- *EU 2020* with the *Roadmap to a Resource Efficient Europe*

- the *German National Sustainability Strategy* and *ProgRess*
- *ISO 14000*
- *EMAS*
- *IPP*
- *EU ETS*
- The German *High-Tech Strategy*

According to the detailed analysis and evaluation of the aforementioned activities by the project team, the following GE criteria are particularly addressed by the activities in the topic area of SC:

- ✓ substitution
- ✓ resource efficiency
- ✓ energy efficiency
- ✓ emissions
- ✓ precautionary principle
- ✓ sustainable innovation
- ✓ transfer of knowledge
- ✓ polluter pays principle
- ✓ intergenerational justice
- ✓ international cooperation
- ✓ targeted environmental legislation
- ✓ quality of life
- ✓ integrated decision-making
- ✓ fairness (environmental justice global-local)
- ✓ effective enforcement
- ✓ rule of law

To a lesser extent, the following criteria are fulfilled:

- ✓ biodiversity
- ✓ education
- ✓ life cycle assessment
- ✓ sustainable product design
- ✓ climate protection (low-carbon)

4.4 Discussions on Green Economy

For reliable statements on whether, if, and how far the three topic areas of this analysis can be integrated into the current political and expert discussions and to elaborate the respective proposals and provide arguments, the ongoing discussions have to be analysed in detail.

4.4.1 International Discussions

The most important international discussions concerning the

implementation of the *United Nations Conference on Sustainable Development (Rio+20)* (see chapter 4.3.4) are the UNEP *Green Economy Initiative (GEI)*, UNIDO's *Green Industry Initiative (GII)*, and the *Green Growth (GG)* strategy of the OECD [OECD 2014].

GEI [UNEP 2014]: The key elements of the initiative are the progress indicators, which were developed in cooperation with OECD and World Bank. The *GE* indicators combine the subjects of i) green transformation of key elements of the economy, ii) decoupling and efficiency, and iii) collection of indicators concerning progress and welfare. The single states can prioritise the indicators according to the economic development of the respective country [OECD 2014]. The topics can be divided into the following groups of indicators:

1. socio-economic context and characteristics of growth
2. productivity related to environment and resource
3. basis of natural capital
4. environmental quality of life
5. economic possibilities and political activities

A comprehensive table of the criteria and all subgroups and indicators can be obtained from the annex of the German report in chapter 11.

The *Green Growth Knowledge Platform (GGKP)* and the corresponding *GGKP Scoping Paper* [Kozluk et al. 2013], which are managed together with UNIDO, were utilised to develop sets of indicators for the evaluation of green growth and GE. The scoping paper demands the international harmonisation of standards and definitions and complains about the lack of transparency of indicators.

GII [UNIDO 2014]: The UNIDO concept focuses on the sustainable industrial development through public green investments and political initiatives, which shall encourage the sector to act environmentally friendly. The major aspects of the *GII* include the greening of production processes and the development of a green industry for goods and services, which also includes their export. The *GII* supplements the *GEI*, and together, they manage the *Green Industry Platform* [GIP 2014]. So far, green investment is mostly considered to focus on climate protection and CO_2 reduction. However, green investments are first and foremost investments into renewable energy, clean technologies, environment technologies, sustainable markets, and climate protection. UNIDO emphasises that there is a large number of different definitions with altering focuses and underlines the necessity for an enhancement and harmonisation of these definitions [Inderst et al. 2012].

GG [OECD 2011: To enable economic growth and development by simultaneously maintaining natural resources and ecosystem services, targeted investments and innovations are required. In order to promote this development, the OECD published studies, papers, and strategy packages [OECD 2014], which help record green growth and progress on a global scale and announce new possibilities and problems. Furthermore, the organisation works on indicators of *GG* [Koźluk et al. 2013], which address the following fields and topics:

- natural resources: innovation, energy, material, carbon, water, waste
- environmental and resource productivity/intensity: aquatic resources, forest resources, mineral and energy resources, soil and land resources, water resources, biodiversity
- environmental quality of life: health, risks, water, ecosystem services, employment, political instruments, international cooperation
- socio-economy: overall economy, trade and regulations, distribution, labour market, education and training, health and healthcare, development

To facilitate the communication and the transfer of indicators, the OECD currently works on a smaller catalogue of major indicators for green growth [Kożluk et al. 2013]. The complete list can be obtained from appendix I of the German report.

4.4.2 European Discussions

The most important discussion process on the European level is the strategy *Europe 2020* (see chapter 4.3.5). The implementation and enhancement of this strategy are promoted by the European Environment Agency (EEA) [EEA 2014] and the *European Resource Efficiency Platform (EREP)*. In addition, voluntary initiatives by the industry regarding corporate social responsibility are discussed within the frame of the *CSR strategy*. According to the suggestion of the European Commission in 2011, the CSR is “the responsibility of enterprises for their impacts on society” beyond legal provisions [EU COM 2011a].

4.4.3 National Discussions in Germany

In Germany, the central political elements on GE are the *National Sustainability Strategy* and the *High-Tech Strategy 2020* (see chapter 4.3.6). Discussions about implementation and enhancement of those strategies are mainly fostered by the BMBF/BMUB *Agenda Process Green Economy* and by the *International Conference on Sustainable Business and Consumption (SusCon)*.

Agenda Process Green Economy: In September 2012, the BMBF and BMUB started the *Agenda Process Green Economy* in Germany [BMBF]. The key elements of the GE agenda are finding answers on questions about topics such as energy/climate, resources, welfare/justice, and governance including funding [BMBF]. The discussion is open to all areas of industry.

In order to establish a permanent dialogue on research questions and framework conditions, *GE workshops*, which elaborate contents for a research agenda, were developed. The most current workshops in 2013 [BMBF] were concerned with the entire value-added chains and networks as well as with the life cycles of products. Major discussions focused on closed material cycles and the use of renewable raw materials (coupled bio-refinery concepts and cascade utilization).

The financial area is concerned with the security of investments, transparency, and reliable framework conditions. In 2012, the key issues included simplification of funding conditions and financial incentives, CO_2 pricing, reduction of subsidies for fossil fuels, development of new business models (e.g. energy contracting), risk control and assessment for sustainable financial and insurance

products, and information for and participation of the society and public. A central result is the abandonment of renewable energies as the single assessment tool and the strengthening of the importance of other resources. In 2013 [BMBF], the focus lies on the funding for long-term innovations and infrastructures, new investment and innovation models, business and hedging models, integration of sustainability criteria for investments, funding, rating and insurance, market opportunities and performance of sustainable capital investments, and ethical financial standards.

Considering labour and production, the focus lies on Green Economy versus Greening of the economy and of jobs. The consideration of value-added chains instead of the analysis of individual sectors as well as a suitable frame for research programmes have been emphasised as important aspects in 2012. Enterprises and industry are requested to be proactive regarding resource-saving and energy-efficient production, integration of social and ecological aspects, and the development of monitoring approaches for policy and intermediary organisations. Additional key issues are the improvement of funding instruments for more sustainability especially in small enterprises, the promotion of technology acceptance in the public, and the configuration of national regulations in order to maintain German production. Regarding the chemical industry, its function of providing sustainable products for other industrial sectors and the challenges accompanying the implementation of closed material cycles are particularly discussed.

The creation of reliable labels and certification schemes for environmental and social standards and the discussion between consumer and producer about the supply of sustainable/durable products are the key issues concerning sustainable consumption. In 2013 [BMBF], the analysis, quantification, and prevention of rebound effects as well as additional new technologies for consumer information and promotion of sustainable consumption were the most important topics.

Major questions about sustainable energy supply and use [BMBF] in 2013 included the configuration of regulatory measures and incentives in order to achieve the efficiency goals of companies.

Memorandum for a Green Economy: The brochure, which has been jointly elaborated by the BMUB and BDI, refers to the following as key aspects of the creation of a GE in Germany:

- a further reduction of harmful emissions into all environmental bodies
- further improvement of waste prevention and recycling, of environmentally sound disposal, and of closed material cycles as far as possible

- further reduction of the use of non-renewable resources and a more efficient use of energy, raw materials, and natural resources
- an ongoing substitution of non-renewable resources with sustainably produced renewable resources
- the achievement of a long-term based energy supply that is strongly based on renewable energies
- the maintenance and restoration of biological diversity and ecosystems and their services

SusCon [SusCon 2012]: The conference series on sustainability are organised by Organic Services Colabora and Forum CSR. The Federal Ministry for Economic Cooperation and Development (BMZ), BfN, the European Development Fund, and the Wuppertal Institute Collaborating Centre on Sustainable Consumption and Production (CSCP) are co-organisers.

Amongst others, the topic of greenwashing was discussed at the first conference in 2009. At the second conference in 2010, the emphasis was on business and biodiversity [SusCon 2012], and the third conference in November 2012 focused on a sustainable supply chain and requested a strengthening of free and fair trade for the global economy.

The conference resulted in the insights that neither political nor industrial stakeholders take on enough responsibility for sustainable development and that the cooperation in particular is not functioning properly.

The main barriers for the creation of a GE were identified to be legislation, current market conditions, technical and financial performance, a lack of examples, missing involvement of local governments and authorities, and consumption behaviour.

Sharing was identified as an important concept for the future of sustainable consumption (“sharing is the new owning”), which needs advertisement and awareness in the society. An additional concept is the *Product Service System (PSS)*, represented by the *ChL* business model as well as by other approaches like B2B (business to business), B2C (business to consumer), and C2C (consumer to consumer).

Regarding sustainability criteria and labels, the *Voluntary Sustainability Standards (VSS)* of the UN Forum on Sustainability Standards were introduced as a basis for legally binding label standards.

The *ISEAL Platform* [ISEAL Alliance 2012] was mentioned as an example for the establishment of a sustainability mainstream by sharing

information of hot spot analyses between different actors from economy and industry.

Considering sustainable resource use, the conference complained that holistic approaches, such as sustainability strategies for the whole company including the supply chain, are missing. Moreover, it was emphasised that sustainability has to be measurable or quantifiable for everyone, for example, through life cycle assessments or transparency. The support for innovative technologies and a stronger integration of governments were also highlighted.

Germany has an additional CSR strategy [BMAS 2014]. It especially emphasises voluntary action beyond legal regulations and underlines the necessity for the promotion of incentives for CSR as well as better announcements of socially responsible commitment of enterprises (see also German Sustainability Code chapter 4.3.6).

5 Important Voluntary Initiatives of Industry, Non-Governmental Organisations, and Research Activities Connected to Sustainable and Safe Chemicals Management

The following initiatives represent voluntary measures of the industry or specific sectors. They were analysed within this category if they did not emanate from the authorities.

This comprises not only research projects, management initiatives, or awards to chemical associations or enterprises but also strategies and instruments for implementation by non-governmental organisations (NGOs) or approaches for sustainability assessments from the financial sector.

The approaches discussed within this chapter constitute an addition to the legal and political initiatives that were explicated in the previous chapter. Again, it has to be emphasised that this list of activities is by no means exhaustive but depicts only the important and trend-setting measures.

Table 5-1 summarises all voluntary initiatives within the three topic areas of E&H, CS, and SC, which are described in more detail below.

Table 5-1: Overview of the discussed voluntary initiatives

Environment and Health	VCI/BMUB Prioritization of substances for HBM Pilot Project for the harmonization of HBM in Europe Integrated Assessment of Health Risks of Environmental Stressors in Europe (INTARESE) with Integrated Environmental Health Impact Assessment System (IEHIAS) ICCA Long range Research Initiative
Chemical Safety	Global Product Strategy (GPS) with GPS Safety Summaries Responsible Care of the ICCA Blue Angel (RAL; jury environment label) Voluntary Emissions Control Action Programme (VECAP) on brominated flame retardants European Network for Silica NEPSI CSR from BASF
Sustainable Chemistry	ICCA's Responsible Care European Technology Platform for Sustainable Chemistry (SusChem) European Sustainable Chemistry Award Global Chemical Leasing Award Global PSC Global Reporting Initiative (GRI) Chemie hoch 3

	Chemistry Innovation Transfer Network
	Process Intensification
	The Natural Step (TNS)
	AIChE - Die Total Cost Assessment (TCA) Methode
	Cradle-to-Cradle® concept
	Green Screen
	Seebalance®
	ACHEMA
	Cleanright
	HoechstNachhaltig- Sustainable development
	Bayer Climate Protection-Programme
	Chemical Parks
	Product Resource Efficiency Project
	Henkel- Climate Compatible Consumption

5.1 Voluntary Initiatives on Environment and Health

VCI/BMUB Cooperation for the Prioritization of substances for HBM [VCI 2013]: This joint initiative aims at developing methods of analysis and biomarkers for HBM for prioritised chemical substances that are so far not measurable in the human body fluids. It focuses on the substances that the public strongly expose or that have a significantly high effect on health [UBA 2014]. This method development decisively supports the implementation of *REACH* in Germany by systematic monitoring.

Pilot Project for the harmonization of HBM in Europe [COPHES 2012]*:* In order to generate comparable figures for a Europe-wide control of chemicals, a pilot project funded by research budgets, the necessary framework, and standards for a harmonised survey were created in 24 EU member states. In 17 countries, a first set of comparable values was generated. Thereby, the projects provide an important basis for internationally comparable data and also contribute to transfer of knowledge and harmonisation of capacities.

Integrated Assessment of Health Risks of Environmental Stressors in Europe (INTARESE) [Imperial 2013]*:* The European Chemical Industry Council (Cefic) participated in this EU research project, which developed methods and tools for the health risk assessment as a result of environmental impacts like air quality, water pollution, and climate change. The results of the case studies were transferred to an Integrated *Environmental Health Impact Assessment System (IEHIAS)*, which provides options for integrated health risk assessment and decision-making. Additional goals of the *INTARESE*

project were the cooperation and transfer of knowledge between European members and a harmonisation of the member states' policy.

Long-range Research Initiative (LRI) [ICCA 2014]: One of the objectives of this International Council of Chemical Associations (ICCA) research initiative is a modern and improved chemicals management. In order to better and faster address prospective problems, the access to scientific consultation for industry and politics has to be improved. Transfer of knowledge and communication are important parts of this programme. Current research focuses on new technologies and exposure research as well as their interpretation regarding E&H.

5.1.1 Summary Evaluation of the Fulfilment of Green Economy Criteria through Activities on Environment and Health

After a detailed evaluation of the aforementioned measures, the project team especially considers the following criteria to be met by these E&H activities:

- ✓ emissions reduction
- ✓ sustainable economic innovations
- ✓ precautionary principle
- ✓ integrated decision-making
- ✓ measures go beyond GDP; indicators/index
- ✓ protects biodiversity/ecosystems
- ✓ promotion of the quality of life
- ✓ transfer of knowledge
- ✓ international cooperation

Appendix VI of the German report provides a detailed table containing the most contributing activities for this assessment in the topic area of voluntary E&H initiatives.

5.2 Voluntary Initiatives on Chemical Safety

Global Product Strategy (GPS) [ICCA 2014]: The *GPS* initiative shall help to improve and adjust the global chemicals industry's level of product responsibility. Therefore, it provides information on danger and exposure of chemicals and guidelines for transfer of knowledge. Additional key issues are the method development, innovations, risk identification, capacity building in SMEs and developing countries, and public access to scientific information regarding product safety within the entire supply chain. The major tool of the strategy is an internet portal that contains downloadable *GPS Safety Summaries*, which are reports about chemical substances, their properties, and safe application.

Responsible Care (ICCA) [ICCA 2014]: The initiative aims at a continuous improvement of enterprise performance in the fields of environment, safety, and health. With its *Responsible Care* programme, the chemical industry wants to contribute to solving those global environmental problems that are in their area of competence. The aim is to establish a transparent and open communication and interaction among all the relevant contributors worldwide and to oblige them to use their resources efficiently and to reduce the amount of waste generated. Furthermore, the initiative shall support sustainable development and produce more sustainable

and less harmful substances. The initiative respects the states' different starting positions, which require different definitions of the respective key elements of the strategy. For this purpose, the *Responsible Care* network provides information, check lists, and indicators. Further measures of *Responsible Care* aim at targeted cooperation with government agencies to implement societal projects. Examples include the creation of new habitats and educational programmes at schools. As a tool for the implementation of *SAICM*, *Responsible Care* contains both aspects of SC and CS and thus can be assigned to both subjects.

Blue Angel: The *Blue Angel* is an environmental label supported by the government (*contracting authority (RAL); Ecolabel Jury)* but is described here in this chapter because the participation from the industry is voluntary. The *Blue Angel* awards its eco-label in the areas of E&H, climate (GHG), water, and resources (raw materials, energy). Environment and health protection as well as sustainability over the life cycle are the rules for receiving this label. The international cooperation of the *Blue Angel* with other label systems shall be promoted in order to establish common traits of awarding labels and to achieve transboundary recognition of the different labels. The eco-label enables the consumer to readily identify sustainable products and consequently supports sustainable consumption. Moreover, the website continuously informs the consumers about new sustainable products and about behaviour that may lead to a more sustainable way of life.

Voluntary Emissions Control Action Programme (VECAP) [VECAP 2014]: The voluntary initiatives of EFRA (European Flame Retardant Association) and BSEF (Bromine Science and Environmental Forum) want to raise further awareness on the handling of brominated flame retardants along the entire value-added chain and want to reduce the emissions into the environment. The programme defines principles of appropriate chemicals management.

The European Network for Silica (NEPSI) [NEPSI]: *NEPSI* was developed as a dialogue between employers and employees. Key topics are the health protection of the employees and advanced knowledge about potential health impacts due to respirable crystalline silica and its products. The international network offers examples of good practice, organised health supervision, and information as well as instructions. The compliance of the agreement is controlled via self-monitoring by the network.

Sustainability initiatives of single chemical enterprises: A number of voluntary sustainability initiatives exist in the chemical industry that are referred to as examples of good practice within this report. According to the ranking from the German Institute for

Ecological Economy Research (IÖW) [IÖW 2014] on sustainability reports of large German companies, BASF, Bayer, Henkel, and Wacker Chemie in particular are mentioned here. BASF is ranked number 3 after BMW and Siemens. Bayer, Henkel, and Wacker Chemie are among the list's best 14 companies. Thus, they belong to the top 33% of the analysed enterprises. The sustainability strategy of BASF strongly relates to *Responsible Care*. Key aspects of BASF's strategy are energy, product responsibility, health, safety, and environment along the supply chain.

5.2.1 Summary Evaluation of the Fulfilment of Green Economy Criteria through Activities on Chemical Safety

After the detailed assessment of the aforementioned measures and the GE criteria, the following aspects are duly covered regarding the implementation of a GE:

- ✓ resource efficiency
- ✓ energy efficiency
- ✓ emissions reduction
- ✓ reduction of waste
- ✓ low-carbon (GHG reduction)
- ✓ sustainable economic innovations
- ✓ life cycle assessment
- ✓ integrated decision-making
- ✓ measures go beyond GDP
- ✓ quality of life: poverty alleviation, well-being, protection of natural livelihood
- ✓ fair working conditions and health and safety at work
- ✓ supports labour and human rights
- ✓ enables education/training
- ✓ transfer of knowledge
- ✓ international cooperation

Appendix VII of the German report contains the explanations for this assessment in tabular form and lists the most important voluntary activities that contribute to the stated GE criteria.

5.3 Voluntary Initiatives on Sustainable Chemistry

Responsible Care: (see chapter 5.2)

SusChem [SusChem 2012]: The initiative was founded in 2004 by Cefic, the Society for Chemical Engineering and Biotechnology (DECHEMA),

the European Association for Bioindustries (EuropaBio), the GDCh, the European Section on Applied Biocatalysis (ESAB), and the Royal Society of Chemistry (RSC). Its objective is to facilitate R&D projects in sustainable chemistry and biotechnology. *SusChem* implements these goals via *SusChem National Technology Platforms* and develops recommendations for research funding by strongly cooperating with the funding agencies. A horizontally-organised *SusChem* committee is concerned with overarching topics such as education and training, framework conditions for science-industry corporations, safety aspects, regulations, and venture capital. A group of the member states ensures the connection with the national research promotion. Partners along the value-added chain are also involved in the platform. Amongst others, the single working groups of the technology platform collect examples of good practice of governmental innovation promotion and of cooperations between economy and science from the *SusChem* countries. In addition, the initiative formulates objectives for the implementation of a SC such as the reduction of resource demand and waste production, the substitution of hazardous substances, and process intensification (PI). The consumption behaviour is also addressed [SusChem 2006].

A national Implementation Action Plan was already elaborated in Germany in September 2006 and has strong overlaps with the government’s *High-Tech Strategy*.

Chemie hoch 3 [Chemie hoch 3 2014]*:* The national initiative, with the participation of VCI, the German Trade Union for the Mining, Chemical and Energy industries (IG BCE) and the *Employers' Federation for the Chemical Industry* (BAVC), aims at establishing sustainability as a core concept within the sector. The protection of humans and the environment and the commitment for good and fair working conditions are considered to be the basic principles of action. Examples are the *Responsible Care programme* and the *Chemical Industries Social Partnership. Chemie hoch 3* expresses its commitment in the *Guidelines for Sustainability of the German Chemical Industry* and in the sustainability report of May 2013. The guidelines include recommendations to 12 priority areas for a GE:

1. Integration of economic, ecological, and societal sustainability into a company’s strategy: The company shall develop individual goals to continuously adapt to the basic principles of sustainable development. The employees will actively take part in this process. The protection of humans and the environment and responsible handling of resources shall be strongly anchored within the companies. For example, they shall be supported by the implementation and continuous enhancement of *Responsible Care*. Human rights shall be respected around the world.

2. Sustainable enhancement and investments: When investments are concerned, economic efficiency shall be combined with safety, environmental protection, optimised energy and resource use, and social responsibility on the basis of globally comparable standards.
3. Economic stability and global cooperation: The companies shall advocate for high corporate environmental and social standards in their value-added chain.
4. Innovations: When developing new products and processes, sustainable development shall be considered as early as possible.
5. Sustainability in operating processes: The goals are clear responsibilities for the implementation of sustainability measures and the continuous improvement of processes and products. In particular, child and forced labour as well as corruption have to be excluded.
6. Good labour and social partnerships: The *Chemical Industries Social Partnership* gives companies and employees the best chance to balance their interests. Employers shall strongly integrate their workers, who will in turn commit themselves more and show more self-responsibility. The company shall also promote good social standards at the international level.
7. Demographic change and shortage of skilled workers: Companies and employees shall commit themselves to training, lifelong learning, assurance of skilled workers, and appropriate workload at the respective stage of life. Both employers and employees rely on high standards for education and qualification and support the potential of a diverse workforce.
8. Humans, environment and biological diversity: The chemical industry shall advocate for the worldwide protection of humans, the environment, and biological diversity. Special focus shall be put on the product and chemical plant safety as well as on the continuous process optimisation. They shall act according to the principles of *Responsible Care*. Risk assessment at an early stage shall detect and prevent potential risks in products and processes. When utilising the biological diversity for biotechnological or pharmaceutical innovations, the companies shall seek ways to balance economic, ecological, and social interests.
9. Resource efficiency and climate protection: The efficiency of the use of raw materials and energy shall be continuously improved, and entire product life cycles shall be considered. Furthermore, the expansion of the use of renewable and

recyclable resources shall be fostered wherever this is technically possible and appropriate when considering economic, ecological, and social aspects. When extracting resources, the responsible handling of the natural habitats is of high importance. Some key issues regarding resources and climate protection are the reduction of emissions from organic solvents by substitution (water based paints) and improved recycling systems in order to prevent or better reuse hazardous wastes.

10. Sustainable development at national and international locations: Engagement for higher qualities of life and civic participation. Support of future and education opportunities for young people.

11. Transparency and integrity: Transparent and reproducible sustainable commitment on the basis of established standards and indicators.

12. Dialogue and participation possibilities

European Sustainable Chemistry Award: The price, awarded by the European Association for Chemical and Molecular Sciences (EuCheMS), shall contribute to strengthening SC, stimulating innovations, and encouraging competitiveness. The award honours scientists who significantly contributed to sustainable development by applying “Green Chemistry” [EuCheMS 2014]. Central fields of action include i) synthesis, ii) analytical science, iii) catalysis, iv) chemical biology, v) computational chemistry, vi) electrochemistry, vii) material chemistry, and viii) supramolecular chemistry and nanotechnology. The goals include product design and the use of chemicals while taking into account potential sustainable substitutes, waste minimization, resource efficiency, and application of renewable raw materials.

Global Chemical Leasing Award [BiPRO]: In order to increase the awareness and the importance of *ChL* worldwide, the presentation of the *Global Chemical Leasing Award* was initiated in close collaboration with UNIDO, the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, and the BMUB. The award criteria refer to the implementation of the goals and the underlying basics of the *ChL* initiative (see chapter 4.3.1).

Chemical parks: Chemical parks are a possibility for companies to efficiently use energy and resources by jointly using coupled products, waste, or resources. In addition, the demand for resources and the emissions into the environment can be reduced. A well-functioning chemical park is located in Kalundborg, Denmark. There, a 1,500 MW coal-fired plant produces the energy for all resident companies as well as for 3,500 nearby households. The waste heat of the plant is utilised by a pharmaceutical company [Kalundborg Symbiosis]. A German example is the Industrial Park in Frankfurt am Main [Infraserv & Höchst 2014]. At this state-of-the-art location for chemical and pharmaceutical industry, 22,000 employees work for 90 companies. Due to the size of the park, 250 raw materials are available in the facility without additional transport, and process aids such as steam and cooling agents or different qualities of water are locally available.

Chemistry Innovation Transfer Network [TSB 2014]: The innovation network for the British chemical industry is financially supported by the government’s Technology Strategy Board and is managed by industry stakeholders. Essential tasks of the network include the provision of information about critical raw materials, market

openings for bio-based products, and the exchange between science, industry, and the government. The use of biomass or waste as raw materials, the application of new technologies in order to substitute critical metals, and intelligent production processes are major topics of the network. Another key aspect is the innovative design of products to increase the functionality. Crucial instruments of the network are the *sustainable design guide* [TSB 2014], a website on *smart chemistry* [TSB 2014] containing information on efficiency, and a website about the funding for sustainable development, the special needs of the chemical industry, and the practical examples for innovative processes.

Working Party on Process Intensification [TSB 2014]: Process intensification (PI) is one of the most important developments in chemistry and process engineering during the last years. PI allows process plants to be smaller and simpler, better controlled, more energy efficient, and more sustainable regarding the entire chemical processes. National process intensification networks have been around in Great Britain and in the Netherlands for several years. A comparable network, the *RessNet*, has recently been established in Germany (DECHEMA). The Working Party has its origin in the road map for the implementation of PI in the European Union and aims at communicating the potential benefits of PI to the industry and fostering the implementation into production processes. The advantages include energy efficiency, cost reduction due to a decreased amount of raw materials, improved water treatment, and reduced costs because of enhanced processes throughout the entire value-added chain.

PROBE tool for the evaluation of potentials and sustainability LCA [The Natural Step 2014]: The NGO The Natural Steps (TNS) developed a concept about basic principles of sustainability and offers specific recommendations for action and help for companies. The most important instruments are a sustainability manual, a *PROBE tool* for potential evaluation, and a sustainability LCA.

Cradle-to-Cradle® concept [EPEA 2014]: The concept by the Environmental Protection Encouragement Agency (EPEA), which was founded by the former head of Greenpeace chemicals, concentrates on the application of minimum ecological standards and the recycling and reuse of products and materials over the entire life cycle.

Total Cost Assessment (TCA) and Sustainability Index of the American Institute of Chemical Engineers (AIChE) [AIChE 2014]*:* To evaluate successes of sustainability, the organisation and its Institute for Sustainability (IfS) developed an evaluation method and a sustainability index. The *TCA* considers all ecological and health costs of a production process including

- Future costs and contingent liabilities: financial penalties and sanctions that may be caused by non-compliance, accidents, and destruction of natural resources;
- Intangible, internal costs (covered by the company): for example, they help to increase the trust among consumers, to strengthen employees‘ morality, and to enhance the image; they arise from measures of communication;
- External costs (not directly paid by the company): costs that arise in the society, including the degradation of the environment due to legally permissible pollution.

ACHEMA [DECHEMA online 2014]: The world’s largest fair for chemical technology and process industry takes place every two years in Frankfurt am Main, Germany. It is an outstanding platform for innovation and a summit for technologies, which contributes to the promotion of new technologies and to the transfer of knowledge within an international network of experts and executives.

Cleanright [A.I.S.E./Cefic 2009]: The International Association for Soaps, Detergents, and Maintenance Products (A.I.S.E.) and Cefic joined forces for the *Cleanright* initiative, which offers consumers information about different toiletry, cleaning, and care products and their respective environmentally sound and safe handling. A.I.S.E. established a *Code of Good Environmental Practice* [A.I.S.E. 2012] for its members. A key element of the code is the promotion of sustainability of powders and fluid cleaners and an appropriate communication of information to consumers.

Product Sustainability Assessment (PROSA) [Grießhammer et al. 2007]: In 1997, within *HoechstNachhaltig- Sustainable development* [Ewen et al. 1997] the HOECHST AG and the German institute for research and consultancy Oeko-Institut developed an instrument for the evaluation of the sustainability of products. *PROSA* enables a strategic analysis and evaluation of products and services for the entire line of products and future development paths. Ecological, economic, and social opportunities and risks are evaluated by using life cycle assessments, life cycle costing and megatrend analyses (general market movements). The analysis may be used for strategic planning, for the identification of future markets, for sustainable consumption, and for product evaluation, development, and marketing. In addition, *PROSA* helps to analyse technologies and major infrastructure projects.

Socio-economic efficiency analysis Seebalance® [BASF 2014]: This method was developed by BASF and is able to conduct a socio-economic efficiency analysis by including costs of environmental burdens and social consequences of the goods and their production processes. Besides listing the overall costs of ecological and economic

burdens, it is also the objective to disclose the use of the respective product over its entire life cycle.

Green Screen [Clean Production Action 2014]: *Green Screen* is a commercial American tool to comparatively assess risks of chemicals on the basis of hazard classifications and reference values. It can be used in order to identify harmful chemicals and safe alternatives in a direct comparison.

Bayer Climate Protection Programme [Bayer 2014]*:* In 2007, Bayer AG started a programme to follow its comprehensive climate protection targets and to foster innovative solutions for the reduction of GHGs. The enterprise's programme is concerned with the following: i) efficient production: emissions reduction in the production by enhancing the energy and resource efficiency and by developing and implementing new technologies; ii) market solutions: emissions reductions by the application of the company's products for building insulation, for lightweight automotive engineering, and for agriculture; and iii) supporting measures: emissions reduction in company sectors such as the vehicle fleet, the use of information technology, and the active participation from workers.

5.3.1 Summary Evaluation of the Fulfilment of Green Economy Criteria through Activities on Sustainable Chemistry

After the detailed assessment of the aforementioned measures and the GE criteria, the following aspects are particularly covered regarding the implementation of a GE:

- ✓ substitution
- ✓ resource efficiency
- ✓ energy efficiency
- ✓ emissions reduction
- ✓ reduction of waste
- ✓ reuse and recycling
- ✓ renewable raw materials
- ✓ low-carbon (GHG reduction/emissions reduction)
- ✓ sustainable economic innovations
- ✓ sustainable product design
- ✓ precautionary principle
- ✓ life cycle assessment
- ✓ integrated decision-making
- ✓ measures go beyond GDP

- ✓ biodiversity
- ✓ quality of life: poverty alleviation, well-being, protection of natural livelihood
- ✓ fair working conditions and health and safety at work
- ✓ intergenerational justice
- ✓ enables education/training
- ✓ transfer of knowledge
- ✓ international cooperation

Appendix VIII of the German report provides a detailed table providing an explanation and of the most contributing activities for this assessment in the field of voluntary initiatives. Thus, this summary provides a basis for the recommendations in chapters 7 and 8.

5.4 State of Resource Efficiency and Remaining Potentials from the Perspective of the German Chemical Industrial Association

According to the VCI [Ritz 2005], the chemical industry accomplished to reduce their total energy demand by 21% and their GHG emissions by 50% between 1990 and 2010 although the production capacities increased by 58% during the same period of time. In order to save primary sources of energy, waste heat from chemical production processes, electricity and heat from the incineration of sewage sludge and waste, biogas from organic compounds of the industrial wastewaters, and energy from domestic waste incinerators are utilized as new sources of energy. Today, the chemical and pharmaceutical industries have an overall energy demand of 660,000 terajoule (TJ) (387,000 TJ from natural gas, 190,000 TJ from electricity, 43,000 TJ from oil, and 36,000 TJ from coal).

The VCI states that this seemingly high energy consumption is opposed by the energy saving and climate protection potentials of the produced goods. Thus, the VCI requests - especially for the chemical industry - an integration of the emission savings over the entire lifetime of products into the sustainability criteria for a GE. Examples for these kinds of products are insulating boards made of polystyrene and polyurethane, insulating double glazing, energy-saving lamps and LEDs, modern detergents, fuel-saving tires, high-performance batteries, etc.

Regarding the resource demand, the German chemical industry has already achieved considerable savings, and the industry is generally characterised by a high material efficiency due to continuous improvements of the production processes. As an example, VCI mentions the developments in the production of polypropylene. The

raw material input decreased to 1,005 kg per tonne by 2005, which equals a production efficiency of 99%.

Overall, the German chemical industry necessitates about 18.5 mt of fossil resources. For crude oil (15.3 mt), this correlates to a sixth of the German annual total consumption. The demand for natural gas is about 3 mt and for coal about 0.2 mt. Currently, most of the natural and a large share of the mineral resources are imported.

Renewable raw materials important to the chemical industry include vegetable oils (tensides, lubricants, varnishes and paints), timber (wood-based materials, paper pulps, synthetic cellulosic fibres), starch (paper, enzymes for detergents, chemical basics), and natural rubber (elastomers). About 2.7 mt renewable raw materials are currently utilised, which equals to 15% of the entire raw material demand.

According to the VCI, waste prevention and recycling are very important to this industrial sector. In 2007, only 20 kg of waste on average were produced per tonne of raw material. Due to the material and energetic reuse (cogeneration) of the waste (incineration of hazardous waste and mixed waste), the largest share of it was reused. The VCI states that in 2009, unused waste accounted for only a mere 2% of the utilised raw materials.

As per VCI’s opinion, an important instrument to maximise the resource efficiency of the chemical industry is the “Verbund principle”, which employs synergies between utilities and disposal (see chemical parks).

Efficiency potentials also emanate from the applied process technology. According to the VCI information, biotechnology, nanotechnology, and new catalysis processes are three key technologies to significantly increase the resource efficiency in the future. Furthermore, SMEs and particular sectors often struggle to accomplish the entire sector’s efficiency targets although VCI does not provide more information on this issue. Finally, the application and enhancement of chemical products may generate considerable efficiency potentials by, for example, an appropriate eco design (durable products, monomaterials, etc.), reduction of the weight or the material demand (e.g. automotive construction, insulation materials), or recycling.

5.5 Sustainability Initiatives in General and their Applicability for the Chemical Sector

Besides the initiatives directly related to chemistry, several global and national activities promote sustainability in general.

Global Product Stewardship Council (GlobalPSC) [GlobalPSC 2014]: The GlobalPSC is an independent non-profit organisation that seeks for the enhancement of the basic principles of product responsibility.

The aim of the GlobalPSC is to produce goods in a sustainable and clean way by sustainable management measures and by considering the whole life cycle. Sustainability criteria include substitution of toxic chemical substances, waste minimisation by reuse and recycling, resource efficiency, and strict emission directives.

The *Global Reporting Initiative (GRI)* [IFC 2014]: *GRI* offers guidance for CSR reports to develop guidelines, principles, and indicators. Amongst others, the indicators consider energy efficiency, waste reduction and improved recycling, implementation of renewable raw materials, GHG reduction, precautionary measures, protection of ecosystems, just and healthy working conditions, and education and training of employees.

5.6 Sustainable Chemistry Related Initiatives of Other Industrialised Countries

Presidential Green Chemistry Challenge Awards [EPA 2009]: The EPA and the American Chemical Society Green Chemistry Institute® (ACS GCI) have been presenting this chemistry-specific award since 1996. It supports the principles of green chemistry in design, production, and use. Since the inception of the award, 93 winners have been assigned, and up to 2012, 1,490 nominations have been submitted.

Green Chemistry Resource Exchange (Green ChemEx): The online platform of the ACS GCI supports the exchange of information about resources and sustainable chemistry and aims to inform the general public. The database also offers access to practical examples of implemented efficiency potentials of particular sectors. It is based on the cooperation with the EPA.

5.7 Sustainability Initiatives of the Financial Sector

Throughout the last years, funding instruments have been concerned with the topics of sustainability and GE and have begun to emphasise certain aspects.

5.7.1 International Financial Instruments

Exemplary approaches include an initiative of the World Bank for green growth with measurable sustainability standards and a workshop of the International Monetary Fund (IMF) and UNEP on the development of tax measures for a GE. Worth mentioning are also the different sustainability indices.

The GE in a blue world series [The World Bank 2013] is an initiative of the World Bank for green growth.

The *International Monetary Fund (IMF)* organises a workshop for the development of tax measures for a GE [UNEP 2014].

As an example for a development bank of another continent, the African Development Bank (AfDB) sets priorities for funding on

transformation, comprehensive approaches, sustainable growth, welfare, appreciation of human, social, and natural capital as well as efficient and sustainable use of ecosystems and ecosystem services. [AfDB]

International Finance Corporation (IFC): The society of the World Bank group has its focus on the private sector in developing countries and developed the *Sustainability Performance Standards* that shall be implemented by their customers through the *GRI* Reporting Framework [IFC 2014]. The publication underlines the role and necessity of investments with respect to environmental, social, and governance factors.

DOW Jones Sustainability Index (DJSI) [RobecoSAM AG 2014] and *Calvert Social Index* [Calvert Investments 2014]: Besides the economic criteria, these American sustainability indices also address the environmental and social criteria of growth. Hence, they are neither purely economic nor ecological. The *DJSI* is divided into three index groups: global, European, and North American. By means of sustainability criteria, the index assesses companies worldwide. Thus, it is an incentive for environmentally conscious investors. Of every sector, only the top 10 % enterprises are included in the index. The *Calvert Index* refers to the enterprises that act socially responsible or respect ethical criteria.

FTSE4Good Environmental Leaders Europe 40 [FTSE 2010]*:* This index of the British FTS group, a subsidiary of the London Stock Exchange, provides information about the European companies that apply leading environmental measures. This comprises companies that implement more measures than others to prevent environmental risks and impacts and to reduce their ecological footprint.

5.7.2 National Financial Instruments

As a promotional bank owned by the federal government and the federal states, the Reconstruction Credit Institute (KfW) [Seidel 2013] supports sustainable improvement of economic, social, and environmental boundary conditions in areas such as small enterprises, entrepreneurship, conservation, housing industry, infrastructure, education promotion, project and export funding, and development cooperation [KfW 2010].

The KfW manages a Green-Economy.de expert blog in order to exchange information, and this serves as a platform for a network of experts of economy and capital market, policy, and science. The blog mainly offers background information about current developments, market analyses, political decisions, and trend movements. The current topics in discussion focus on renewable energies, sustainable agriculture, and environmental investments (in renewable energy

funds). In September 2013, KfW organised the conference *Scaling-Up GE 2013* [KfW 2013], which representatives from 15 development finance organisations and development banks of industrialised countries agreed on a stronger cooperation to jointly promote green investments in developing and transitional countries.

The Association of German Banks *Finance-Forum: climate change:* With respect to climate change, the association discusses the potentials arising from specific challenges of a GE for the financial sector. Banks and savings banks as well as insurances may participate in the development of the process within the frame of their respective business to enable the funding and insurance of new technologies and applications. Here, the association contemplates the new role of banks not only as a classical creditor but also increasingly as a problem solver for questions of funding. This comprises, for instance, support for the issuing of bonds, the involvement of subsidies, the creation of new funds, and new shareholding structures for institutional investors and citizens [BMBF].

Association for Environmental Management and Sustainability in Financial Institutions (VFU): The VFU sees GE as a socially and ecologically balanced market economy. A prerequisite for the implementation is the necessity to go beyond compliances of status quo to advanced targets, standards, and indicators that are precise and measurable and to increase the transparency of their compliance. Although VFU describes its understanding of GE with respect to the financial service sector, the criteria could principally be utilised by banks for an active support of a general GE. Financial service providers shall disclose to stakeholders and customers regarding which type of investment, which project and to which recipient their funds are invested (earning assets), and which economic, social, and environmental criteria were considered for the decision. The first prerequisite would be to have their own sustainability criteria, i.e. reports extended by social and environmental information on an internal or external level. Instruments for internal control are developed in many cases. This also applies to external reporting (e.g. GRI, sustainability rating, VfU indicators, E-DRS 27), guidelines, and standards (*Global Compact, Equator Principles, UN PRI* etc.).

To the public sector and the legislators, the *VFU* recommends to condense the current variety of criteria and standards, to increase the transparency of the compliance of these criteria and standards (integrated reporting), and to utilise more consistently the governmental possibilities of regulation - incentives as well as sanctions [BMBF].

Industry association for sustainable investment (FNG) [FNG 2014]:

Since 2001, the *FNG* is the industry association for sustainable investments in Germany, Austria, and Switzerland. It has more than 150 company members and is a member of the European umbrella organisation Eurosif. The essential goals include the increase in publicity of sustainable investments, the identification of positive steering functions of sustainable investments for the society and the environment, and the active promotion of development, transparency, and quality of sustainable financial products. The *FNG* is constantly working in the enhancement of quality standards of sustainable investment products and assigns transparency labels for sustainable mutual funds together with Eurosif [FNG 2013]. *FNG* developed profiles of sustainability for funds that specifically include aspects such as environment (sustainable use of natural goods), social affairs (protection of human dignity, poverty alleviation, education, proper working conditions), and governance (responsible business management).

6 Achievements and Deficits of the Involvement of the Chemical Industry into a Green Economy

According to the BMUB's and UBA's definition, GE is an innovation-oriented economy, which reduces the pollution of the environment and is based on closed material cycles. Furthermore, it tremendously decreases the resource demand, achieves renewable energy supply, and therefore protects the climate. GE is generally in accordance with environment and nature. This sustains species diversity and restores natural habitats.

In order to assess similarities and overlaps between GE and the three topic areas of E&H, CS, and SC, the project team identified important keywords, the so-called keywords, that best represent the definitions and that were used to develop the ideal GE criteria.

In this context, sustainable and robust economic activities, innovation orientation, sustainable growth, equality, ecological boundaries, climate protection, globalism, cooperation and interdisciplinarity, and quality of life were identified as important keywords for a GE.

For the topic area of SC, the definitions include the following essential keywords: raw material and energy efficiency, innovation, conservation, health protection, and waste reduction.

For the topic area of CS these keywords are safety (at work) and nature conservation; for E&H, the keywords are health protection and prevention, and the combination of environmental impacts and health is of high importance here. Social aspects such as environmental justice and the conservation or restoration of ecosystems, which is an important factor for health and well-being, are additional important elements.

A comparison shows that the definitions of GE, SC, CS, and E&H are identical with respect to the reduction of environmental and health risks, and they fulfil the criteria of decent working conditions. Several aspects (e.g. resource efficiency, an increased application of renewable raw materials, reuse and recycling, innovation, biodiversity and ecosystem services), social considerations (e.g. equality, poverty alleviation, jobs, the special consideration of vulnerable and socially deprived groups), aspects of urban and regional planning, polluter pays principle, and global fairness were only explicitly mentioned in a few definitions and descriptions (see chapter 3.5).

It is striking that certain criteria are only mentioned in the German definitions. Whilst the GE definition prioritises closed material cycles and renewable resources, the German SC definition

emphasises the precautionary principle, longevity of products, environmental sinks, and competitiveness (see also chapter 3).

After a more detailed analysis of the political and voluntary activities in the particular topic areas, it is obvious that besides these specific keywords in the definitions, additional criteria for specific cases can be mentioned or considered. This may refer not only to specific criteria and objectives, such as the request for substitution, emissions and waste reduction, recycling and reuse, etc. but also to indirect effects like an intergenerational justice due to emissions reduction and substitution or the support of human and workers' rights.

6.1 Achievements of the Chemical Industry with Respect to the Implementation of Green Economy Criteria

A review of the most important political and voluntary activities in the topic areas of E&H, SC, and CS show that during the last years and decades, a lot of progress has been made in the chemical sector regarding sustainability and the transformation to a GE.

The Table 6-1 summarises which GE criteria identified within this project are covered by political activities and voluntary measures in the topic areas of SC, CS, and E&H, considering the central aspects and demands of chapters 4 and 5. A summarising table of the most important political activities of every GE criterion can be obtained from the annex IX of the German report.

Table 6-1: Coverage of GE by investigated activities in the three topic areas

	political activities			voluntary measures		
GE criterion	**U&G**	**CS**	**NC**	**U&G**	**CS**	**NC**
1. substitution	x	x	x		x	x
2. resource efficiency			x		x	x
3. energy efficiency	x		x	x	x	x
4. emissions reduction	x	x	x	x	x	x
5. reduction of waste			x			x
6. reuse and recycling			x			x
7. renewable raw materials			x			x
8. low-carbon (GHG reduction)	x		x			x
9. sustainable economic innovations		x	x	x	x	x
10. sustainable product design			x		x	x
11. precautionary principle	x	x	x	x	x	x
13. polluter pays principle		x	x			
15. life cycle considerations		x	x		x	x
16. integrated decision-making	x	x	x	x	x	x
17. indicators	x			x	x	x
18. protection of biodiversity	x	x	x	x		x

	political activities			voluntary measures		
GE criterion	**U&G**	**CS**	**NC**	**U&G**	**CS**	**NC**
19. quality of life	x	x	x	x	x	x
20. fair working conditions and health and safety		x			x	x
21. human and workers' rights	x	x			x	
22. fair (global, national, local)	x	x	x	x	x	x
23. intergenerational justice	x	x	x			x
24. education	x	x	x		x	x
25. transfer of knowledge	x	x	x	x	x	x
26. international cooperation	x	x	x	x	x	x
27. rule of law	x	x	x			
28. targeted legislation	x	x	x			
29. effective enforcement	x	x	x			

6.1.1 Summary Evaluation of the Fulfilment of Green Economy Criteria through Legal and Other Political Activities

The following chapter summarises the GE criteria, which were met by legal and other political activities. It was distinguished between criteria mentioned or fulfilled in all three topic areas (E&H, SC, and CS) and criteria that are mentioned only in two or one topic area. This distinction is important as it identifies criteria that are already broadly acknowledged and play an important role across different field and topic areas. Contrary, criteria mentioned in one topic area only are rather thematic and thus, their contribution to the implementation of a GE is, so far, limited.

Green Economy Criteria Met by Important Legal and Other Political Activities in all Three Topic Areas

Table 6-2 lists the GE criteria that are already mentioned as objectives in all three topic areas.

Table 6-2: Overview of the GE criteria that are covered by activities in all three topic areas.

	Political Activities		
GE Criteria	**U&G**	**CS**	**NC**
1. substitution	x	x	x
4. emissions reduction	x	x	x
11. precautionary principle	x	x	x
16. integrated decision-making	x	x	x
18. protection of biodiversity	x	x	x
19. quality of life	x	x	x
22. fair (global, national, local)	x	x	x
23. intergenerational justice	x	x	x
24. education	x	x	x
25. transfer of knowledge	x	x	x
26. international cooperation	x	x	x

	Political Activities		
GE Criteria	U&G	CS	NC
27. rule of law	x	x	x
28. targeted legislation	x	x	x
29. effective enforcement	x	x	x

The fulfilment of GE criteria is particularly true for the aspects of emissions reduction, the substitution demand of hazardous chemicals, the precautionary principle, the promotion of the quality of life (regarding health protection and conservation), the integrated decision-making, the international cooperation, the transfer of knowledge, the rule of law, and the targeted legislation and its effective enforcement.

For some central approaches, such as *REACH, IED,* pesticides and biocides regulations, water protection, waste management, resource efficiency, climate protection, and health and safety, the European and national legislations have considerably higher standards than the international ones.

For the other GE criteria, such as intergenerational justice, protection of biodiversity, and fairness, it is expected that progress will occur due to the implementation of legal requirements (indirect coverage of GE criteria).

At this point, it shall be stated that the analysis must not be understood in a way that the chemical sector already implemented all aspects of a GE (see also chapter 6.2).

Concerning education, the political initiatives of all three areas emphasise better information for the employees and/or an improved level of education of the general public. However, the project team could not identify any specific objectives for the improvement of any educational level (see chapters 4.4.2 and 4.3.6).

Positive effects on biodiversity within the assessment are a consequence of efficient emissions reductions and substitution measures (expected indirect effect) as requested by, for example, *SAICM*, *REACH*, *WHO PHE*, *IED* regulation, health and safety, pesticides and biocides directives. A direct indicator for the protection of biodiversity was rarely found (see chapter 6.2).

In the topic area of environment and health, at the international level, the WHO's global *PHE strategy* is the key instrument (see chapter 4.1.1). It aims at risk identification, documentation, and minimisation and focuses on global environmental justice and fairness. Because of the global importance of health risks, chemicals play a minor role within this programme compared to air pollution by particulate matter, solid fuels, and water quality.

At a European level (see chapter 4.1.2), the key activity is the *EHP framework process*, which was prepared by the WHO's regional committee for Europe. The central elements of the *EHP* include *EHAPE*, *CEHAPE*, and the *Parma Declaration*, which request for specific targets for the implementations. Further elements are the *ECEH* as a tool for information, research, documentation, and consultation, and the *ENHIS*, the instrument to develop indicators for E&H. Chemicals have stronger priority here at the European level than at the international level although air pollution, water, and accidents still have higher regional priorities.

FP (Horizon 2020) and the *Environmental Action Plan* lie within the area of responsibility of the European Commission and strongly prioritise threats arising from chemicals, the impacts of climate change, and resource efficiency.

At a national level (see chapter 4.1.3) *APUG*, *UPB*, and the *Environmental Surveys*, in particular, are major instruments for the protection of the general public from chemical and environmental risks. The *APUG* is especially an essential measure for risk assessment beyond usual monitoring and supports the awareness raising and information provision for the public. Furthermore, it contributes to the development of possible actions for policy makers.

The activities in the topic area of E&H have the objectives to generate information about causalities and associations between pollution and human health, to monitor pollution and temporary trends, and to provide recommendations for measures of preventions, which can subsequently be implemented by other political activities in topic areas like CS and SC. At the same time, the monitoring and revelation of risks opposed by chemicals and the setting of political goals in context with the transparent documentation on all three levels especially enables the rule of law, targeted legislation, and effective enforcement.

The aforementioned examples generally adopt an integrated approach of decision-making. For instance, the *EHP* with its *EHMB* or the German *APUG* in cooperation with the BMUB, BMG, BMEL, and their federal agencies (UBA, BfN, BfS, RKI, and BfR) can be mentioned here.

In the topic area of chemical safety, the criteria listed[57] in 6.1 are fulfilled on the international level, especially by *SAICM* and

[57] emissions reduction, substitution, precautionary principle, quality of life (in terms of health protection and conservation), integrated decision-making, resource

GHS, the *Stockholm* and *Rotterdam Convention*, the *WHO IPCS* with the database *INCHEM* and the *RAN,* and by the *OECD EHS* with the *SCN* and *CoCap Programme* (see chapter 4.2.1). At the international level, the programmes are less binding than those at the national level. Thus, an implementation at the national level is necessary as this enables the subsequent effective enforcement. The central regulatory elements at the European level are *REACH* and the associated *CLP*, which prioritises all of the aforementioned criteria with its integrative approach (see chapter 4.2.2). In addition, the *PIC* and *POPs directives* as well as the *IED* (see chapter 4.2.4) are positively assessed regarding all these criteria. Out of the laws specifically related to chemicals and products (see chapter 4.2.7), the Plant Protection and the Biocides Regulation, the Fertilisers Regulation, and the Detergents Regulation cover most of the aforementioned criteria well. Naturally, international cooperation is less considered in the European initiatives. At the national level, the *BImSchG, the PfSchG, and the DüMG* were positively evaluated.

All of the aforementioned activities generally highlight the safe handling of chemicals and the prevention of danger occurring due to the application of chemicals. The precautionary principle is generally considered through authorisation obligations, restrictions on use, and obligations for disposal, which thus leads to a significant reduction of threats for humans and environment. This in turn strengthens human and workers' rights implicitly or explicitly and resource efficiency and substitution of hazardous chemicals are promoted. To improve the knowledge about the impact of chemicals on the ecosystem as well as on humans is the major task of *WHO Chemical RAN* (see chapter 4.2.1).

In the chemical sector, *REACH* and *CLP* fostered the implementation of producer responsibility, rule of law, targeted legislation, and effective enforcement more than in other manufacturing industries (e.g. metal processing, energy production, textiles, cosmetics, consumer products). The requirements for international transfer of knowledge and international cooperation are already highly established due to *SAICM, the Stockholm* and *the Rotterdam Convention.*

Within the topic area of sustainable chemistry, the broad coverage of the criteria listed in chapter 4.2.4 is mainly justified by

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efficiency, international cooperation, transfer of knowledge, rule of law, targeted legislation, effective enforcement; indirect: protection of biodiversity, fairness, promotion of education.

SAICM, the Stockholm and *the Rotterdam Convention*, by *REACH, PIC and POP regulations*, by *IED*, and by the specific regulations on chemicals and products. Furthermore, the positive evaluation and broad coverage of these criteria for the topic area of SC are caused by *Agenda 21 and Rio +20* as well as *by the European and German Sustainability Strategies.*

Important examples of emissions reduction, international cooperation, and targeted legislation are the *Montreal Protocol on Substances that Deplete the Ozone,* the *Kyoto Protocol* and the *Minamata Convention* (see chapter 4.3.3).

Substitution, emissions reduction, protection of biodiversity, transfer of knowledge, and integrated decision-making are also important criteria in the *Guide on Sustainable Chemicals, the projects of UBA on ChL* or the expanded NC criteria *of UBA/OECD Workshops* (chapter 4.3.3).

Green Economy Criteria Met in Two Topic Areas

According to our assessment, the GE criteria listed in Table 6-3 are not covered by activities in all topic areas. However, the activities still cover two of the topic areas.

Table 6-3: Overview of the GE criteria that are covered by political activities in two topic areas

	political activities		
GE criterion	**E&H**	**CS**	**SC**
3. energy efficiency	x		x
8. low-carbon	x		x
9. sustainable economic innovations		x	x
13. polluter pays principle		x	x
15. life cycle consideration		x	x
21. human and workers' rights	x	x	

The activities in the topic area of E&H analyse, at all political levels, the aspect of disease risks due to climate change and energy efficiency measures to prevent climate change. The latter ones may arise from a decreased quality of indoor air as a consequence of energy efficiency measures.

Single political initiatives of the SC topic area, such as the *Montreal Protocol*, the *IED*, and national activities like *UBA/OECD Workshop and Going Green*, explicitly demand the increase of energy efficiency and the application of renewable resources as sustainability criteria.

The criterion of human and workers' rights is covered in the topic area of E&H by the single requests from the *PHE* and the *EHAPE*. In the topic area of CS, the *SAICM, Stockholm* and *Rotterdam Convention,*

REACH, PIC and POP regulations, *IED*, and the specific chemicals and products legislations contribute significantly to health protection due to their international focus. Due to the adjustment of working conditions, the *WHO Strategy Safety and Health at Work* with its action plan has to be mentioned in this context as well. The *European Framework Directive on Safety and Health at Work* and its associated directive on hazardous substances and on CMR at work (see chapter 4.2.3) support workers' rights by their demand for information and precautionary health and safety measures taken by the employers.

At the national level, the *Occupational Safety and Health Act* with the *GefStoffV* are important. Worth mentioning are also the activities of BAuA.

Examples of the activities strongly prioritising sustainable economic innovations are *SAICM, ChL* (see chapter 4.2.1), *REACH, IED* (see chapter 4.2.4), *EU 2020,* the *EU SCP, the F-Gas regulation, and the EU ETS* (see chapter 4.2.4). At the national level, the *Guide on Sustainable Chemicals* (see chapter 4.3.3) is the most important activity. This criterion is usually also an important goal of voluntary initiatives like *Responsible Care, GPS* (chapter 5.2)*, Chemie hoch 3, SusChem,* and *GlobalPSC* (chapter 5.3).

Producer responsibility is especially integrated in various laws at the European level. Some important examples include *REACH, IED, the European Framework Directive on Safety and Health at Work, WEEE Directive* or specific chemicals legislations (chapter 4.2.7), and the *EU ETS*. At an international level, the principle is mainly requested by big conventions such as the *Basel Convention*. On the other hand, in our analysis, the GE criterion of life cycle consideration was only covered well by the *SAICM* and *Rio +20*.

Green Economy Criteria Met by One Topic Area Only

According to the project team's analysis, resource efficiency, reduction of waste, reuse and recycling, sustainable product design, and renewable resources are seen as a key aspect only in the topic area SC, whereas measures on fair working conditions and health and safety are assigned to CS only as depicted by Table 6-4.

Table 6-4: Overview of GE criteria covered by activities of one topic area only

	Political activities		
GE criterion	**U&G**	**CS**	**NC**
2. resource efficiency			x
5. reduction of waste			x
6. reuse and recycling			x
7. renewable raw materials			x

	Political activities		
GE criterion	**U&G**	**CS**	**NC**
10. sustainable product design			x
17. indicators	x		
20. fair working conditions and health and safety		x	

Resource efficiency is particularly considered by *UNIDO ChL, the Roadmap to a Resource Efficient Europe*, and the *Guide on Sustainable Chemicals*. The *European SCP* and the *UNEP/UNIDO RECP Programme* are concerned with the waste reduction, reuse, and recycling. Also, the *High-Tech Strategy* aims at a better handling of waste.

The criterion of product design is particularly met by the European *Ecodesign Directive.* In addition, activities such as the *Montreal Protocol*, the *EU Ozone Regulation,* and all other legal regulations on sustainability that contain bans and restrictions on substances or resource efficiency contribute to a change in product design. The *Marrakech Process, SAICM, ISO14001,* UNIDO *RECP, ProgRess,* and the *Guide on Sustainable Chemicals* were assessed positively regarding this criterion.

Our analysis suggests that a prioritisation of renewable raw materials directly related to chemicals management can only be found at the national level and within the *Guide on Sustainable Chemicals*. Beyond that, the increasing application of renewable raw materials is requested in the sustainability strategies at the European and national levels. The use of sustainable energies is an evaluation criterion of the *European Sustainable Chemistry Award* and of the *GRI* sustainability reports.

6.1.2 Summary Evaluation of the Fulfilment of Green Economy Criteria through Voluntary Initiatives

Table 6-5 summarises the GE criteria covered by the different voluntary activities. It is clearly visible that among the voluntary initiatives, the topic areas of SC and CS contribute the most to the fulfilment of the GE criteria. Apart from the rule of law, targeted legislation, and effective enforcement, the allocation of the criteria to the topic areas is, in our opinion, similar to that of the political measures (see chapter 6.1).

A summarising table of the most important voluntary activities can be obtained from appendix IX of the German report.

Table 6-5: Coverage of GE criteria by voluntary measures in the different topic areas

	voluntary measures		
GE criterion	**U&G**	**CS**	**NC**
1. substitution		x	x
2. resource efficiency		x	x
3. energy efficiency	x	x	x
4. emissions reduction		x	x
5. reduction of waste			x
6. reuse and recycling			x
7. renewable raw materials			x
8. low-carbon (GHG reduction)			x
9. sustainable economic innovations	x	x	x
10. sustainable product design		x	x
11. precautionary principle	x	x	x
13. polluter pays principle	x	x	x
15. life cycle considerations		x	x
16. integrated decision-making	x	x	x
17. indicators	x	x	x
18. biodiversity	x		x
19. quality of life	x	x	x
20. fair working conditions and health and safety		x	x
21. human and workers' rights		x	
22. fair (global, national, local)	x	x	x
23. intergenerational justice			x
24. education		x	x
25. transfer of knowledge	x	x	x
26. international cooperation	x	x	x
27. rule of law			
28. targeted legislation			
29. effective enforcement			

The evaluation of the topic area of environment and health showed that the ICCA's *LRI Initiative*, the cooperation of BMUB and VCI to develop new HBM biomarkers and analysis methods as well as the European research project *INTARESE* especially contribute likewise to the transfer of knowledge, international cooperation, and the development of indicators. Hence, they indirectly lead to emissions reduction and the promotion of quality of life. Sustainable economic innovations and the protection of biodiversity were only evaluated positively as targets or consequences of the *VCI/BMUB Cooperation for the Prioritisation of substances for HBM* and of the *LRI*. The precautionary principle is an important aspect of *HBM* and *INTARESE*. The latter one and LRI were also considered positively with respect to integrated decision-making (for further information, see chapter 5.1).

For the approaches in the topic area of chemical safety, the evaluation is mainly based on the contributions of *Responsible Care, Blue Angel, VECAP, GPS, and the NEPSI* initiative (see chapter 5.2).

Responsible Care and GPS are central voluntary initiatives within this topic and do cover all GE criteria listed in the table. This is particularly true for human and workers' rights, reduction of waste, and life cycle considerations as these criteria were only fulfilled by the two aforementioned initiatives. Besides this, other criteria fulfilments are due to the *Blue Angel* regarding climate protection, by *VECAP* regarding emissions reduction, and by the *NEPSI* initiative regarding fair working conditions and health and safety. A high priority of energy and resource efficiency was found in the programmes *Responsible Care* and *Blue Angel*. With respect to the quality of life, mainly *Blue Angel* and *GPS* are evaluated positively. In accordance with the project team's evaluation, the remaining criteria, i.e. education, transfer of knowledge, integrated decision-making, development of indicators, and international cooperation, are covered by all of the aforementioned initiatives.

The analysed initiatives in the topic area of sustainable chemistry cover most of the GE criteria. The major approaches include *SusChem, GlobalPSC, GRI, Chemie hoch 3*, the awards *European Sustainable Chemistry Award* and *Global Chemical Leasing Award*, and the company initiative *Cleanright*. *Responsible Care*, GPS (see chapter 5.2), *Chemie hoch 3*, *SusChem* and *GlobalPSC* specifically consider the criterion of sustainable economic innovations. Only the guidelines of *Chemie hoch 3* explicitly mention biodiversity (for more information see chapter 5.3).

6.1.3 Examples of Good Practice

The presentation of the initiatives in chapters 4 and 5 and the evaluations in chapter 6 result in a variety of political and voluntary initiatives of the three topic areas, which can be termed good practice. It also seems desirable to better implement and transfer these activities to other topics or to extend their field of application.

These examples include many of the existing political activities of the topic areas SC and CS, which demonstrate the substantial significance of chemicals policy for the implementation of GE criteria in the chemical industry and the intensive engagement of the chemical sector with global aspects of sustainability.

According to our analyses, the *SAICM/GHS, REACH/CLP,* the *Stockholm* and *Rotterdam Convention, PIC* and *POP regulations*, and *IED* and *WHO-PHE* are of high importance. Furthermore, important examples include the *EU Health and Safety Regulation,* EU Plant Protection, Biocides, Fertilisers, and Detergents Regulations*, the Ozone Directive, EMAS* and the associated *EU-ETS.* The *Montreal Protocol, the Kyoto Protocol,* the *Minamata Convention, WHO IPCS* and *OECD EHS, UNEP RECP, ISO14001* and *Agenda 21* have to be mentioned in this context as well.

At the national level, *BImschG, PflSchG, DüMG, Sustainability Strategy, High-Tech Strategy and ProgRess* in particular could be identified. Other important national examples include SC workshops, the *Guide on Sustainable Chemicals, ChL,* efficiency agencies, awards, and approaches of communication and funding. Among the industrial initiatives, *Responsible Care, GPS, SusChem, Chemie hoch 3, Global PSC,* and *GRI* are especially striking. Additional detailed information on practical examples of the German chemical industry with respect to resource efficiency and sustainability can be found in the VCI Factbook 05 of 2012, in the 2011 Factbook 04, and in the VCI-CR special on resource efficiency [VCI 2012].

Additional examples of the chemical industry can be obtained from the VDI-ZRE information database and the VDI-ZRE innovation radar [VDI 2014b], from the brochure "*GE in practice: Success Stories in German Companies*," and the *GreenTech Atlas.*

Moreover, chemical companies or chemical research institutes are among the prize winners of the BMUB's/BDI's *Innovation Award*, the *Substainable Chemistry Award*, the US American *Presidential Green Chemistry Challenge Award,* and UNIDO's *ChL Award*.

Innovative projects of the chemical sector can also be found on the DBU homepage. Innovative approaches for resource savings by process intensifications are mentioned in the *European Roadmap for Process Intensification* [Ministry of Economic Affairs] as well as in *ProcessNet*.

Finally, the website of the German eco-label *Blue Angel* also provides examples of the chemical sector. This includes successfully-implemented examples and current products. A summary of the main innovations of the chemical sector listed in these sources can be obtained from the appendix X of the German report.

6.2 Weaknesses and Deficits of the Fulfilment of Green Economy Criteria in the Chemical Industry

Table 6-6 lists the GE criteria that are, according to our analysis, not covered by political or voluntary activities and measures in the topic areas of SC, CS, and E&H.

Table 6-6: GE criteria not or only marginally covered by political or voluntary activities in the three topic areas

	political activities			voluntary measures		
GE criterion	**E&H**	**CS**	**SC**	**E&H**	**CS**	**SC**
12. circular economy			x			x
14. sustainable consumption	x		x			x
15. life cycle consideration	x					
17. indicators			x			

x = the analysed activities do not cover this aspect

Specifically, the lack of useful indicators on SC is obvious for the analysed political initiatives.

In addition, the analysis revealed that the implementation of a real circular economy in terms of material recycling and the explicit demand for sustainable consumption are insufficiently covered by the activities in all three topic areas.

6.2.1 Deficits in the Topic Area Environment and Health

As depicted in Table 6-6, sustainable consumption and life cycle considerations are only marginally or not at all mentioned in the analysed political activities although both criteria would be relevant in this topic area.

For the voluntary initiatives such as ICCA's *LRI initiative*, the research project *INTARESE* with participation of Cefic, and the VCI/BMUB cooperation on analysis methods for HBM no clear deficits could be found by the project team.

6.2.2 Deficits in the Topic Area of Sustainable Chemistry

According to our assessment, circular economy, sustainable consumption, and indicators are not considered appropriately in the activities of the topic area of SC.

6.2.3 Remaining Challenges for the Fulfilled Green Economy Criteria

As introduced in chapter 6.1, a significant amount of GE criteria are already mentioned as objectives in all three topic areas.

However, this does not mean that all of these aspects are already implemented in the chemical industry. It implies that the legislative authority recognised risks and formulated ambitious targets especially during the last years. The practical implementation however may face considerable deficits and challenges that have to be solved, if possible.

By way of example, this is discussed in the following section for the GE criterion substitution.

Regarding the substitution of hazardous chemicals with less hazardous ones, we assume that substitution is theoretically possible. However, during practical implementation, considerable problems occur particularly with respect to finding consensus and the temporal scale. In general, the progress of substitution is too slow, even for the well-known hazardous substances. Given the large variety of chemicals on the market, this may cause massive difficulties with regard to the precautionary principle. For

instance, only 24 hazardous substances have been prohibited, or their use has been restricted (e.g. DDT) after long negotiations under the *Stockholm Convention* since its entry into force ten years ago. Important reasons for those complicated processes of decision-making are the diverging understandings of risks and the different economic interests of the member states. This compromises substitution as well as global justice and competitiveness.

Similar problems with substitution can also be observed for the group of endocrine disruptors. After decades of research and political discussions, no assessment, usage restrictions, or bans have been made or enforced. Furthermore, substitution is fostered by the option of a group ban. Substitutes for brominated flame retardants, the chemical DINCH as a substitute for prohibited phthalates, and medium-chained chlorinated paraffins as an alternative to the prohibited SCCP represent good examples for prohibitions of substance groups.

For the evaluation of criteria fulfilment, it has to be considered that the commitments of requirements significantly increase from the international to the European and the national level (see also chapter 6.2). Regarding the criterion of education, a real increase in the level of training, as proposed by the European and German sustainability strategies (see chapter 4.3.5 and 4.3.6), is only mentioned in the guidelines of *Chemie hoch 3* although all three topic areas emphasise the necessity of improved information of employees and/or an enhanced level of education of the general public (see chapter 5.3).

The positive effect on biodiversity was postulated in the assessment as a side effect of efficient measures in emissions reduction and of the requests for substitution. A direct note to the protection of biodiversity is rarely visible although *Chemie hoch 3* explicitly mentions it (see also chapter 5.3). When utilising the biological diversity for biotechnological or pharmaceutical innovations, the companies seek ways to balance economic, ecological, and social interests.

Although the GE criterion of renewable raw materials is not regarded a deficit in the topic area of SC, it has to be considered as a challenge for the future. It is discussed in direct context with chemicals management only at the national level within the *Guide on Sustainable Chemicals* and the European and German sustainability strategies (see chapter 4.2.4), within the guidelines of the German chemical industry *Chemie hoch 3*, in conferences on sustainability, in programmes like *SusChem*, the *European Sustainable Chemistry Awards*, and in *GRI* reports (see chapter 6.1.2).

6.2.4 Remaining Challenges due to the Current Efficiencies and Potentials of the Chemical Industry

Although VCI underlines the achievements of the chemical sector regarding resource efficiency of raw materials and energy, waste reduction, life cycle considerations, and circular economy (see chapter 5.4), the sector's energy demand is generally high. The amount of renewable raw materials[58] (15%) and the reuse rate have to be increased in order to reduce the demand for primary raw materials by 20% until 2020 and by 50% until 2050 as this is requested by the *Sustainability Strategy*. Because the Verbund Principle is an important approach towards higher resource efficiency, there is a high potential of increase in Germany's 60 chemicals parks and over 9,500 chemical companies. The VCI states that the SMEs as well as specific sectors especially have problems achieving the efficiency targets of the entire sector. Here, the project team considers the availability of financial resources for necessary investments to be a major obstacle.

According to VCI (see chapter 5.4), considerable potentials of increased efficiency exist in the fields of biotechnology, nanotechnology, and new catalysis processes.

The authors of *Going Green* (see chapter 4.3.6) confirm this statement for biotechnology and nanotechnology. However, instead of the catalysis processes, they perceive high potentials for CO_2 as a chemical input material and solar reaction energy and to have more efficient ways of synthesis, efficient energy storage systems, and prevention from dangerous and toxic substances.

Going Green states that the core business of chemical synthesis in particular has to improve and make progress with respect to resource efficiency, whereas the VCI sees great efficiency potentials in the application and enhancement of chemical products by suitable eco-design (e.g. durable products, monomaterials, etc.), materials and weight reductions (e.g. automotive construction, insulation materials), and by recycling.

6.3 Green Economy Criteria beyond the Scope of the Topic Areas

While evaluating the activities of the three topic areas with respect to the GE criteria, it became evident that missing discussions of criteria due to separated legal regulations and responsibilities must not, in all cases, be perceived as a deficit.

[58] vegetable oils (tensides, lubricants, varnishes and paints), timber (wood-based materials, paper pulps, synthetic cellulosic fibres), starch (paper, enzymes for detergents, chemical basics), and natural rubber (elastomers)

Table 6-7 shows a summary of the GE criteria identified in this project that, according to the project team, are not situated in the centre of political attention and beyond the respective regulatory frame. Those criteria are excluded from the assessment. In terms of an integrative approach, however, those aspects may become more relevant in the future, and recommendations for actions in the single topic areas for the responsible authorities may be useful.

Table 6-7: Overview of the GE criteria that were excluded during the assessment in single topic areas as they were outside the responsibility or area of influence

	political activities			voluntary measures		
GE criterion	**E&H**	**CS**	**SC**	**S&H**	**CS**	**SC**
2. resource efficiency		x				
3. energy efficiency		x				
5. reduction of waste	x	x		x	x	
6. reuse and recycling	x	x		x	x	
7. renewable raw materials	x	x		x	x	
8. low-carbon (GHG reduction)		x		x	x	
9. sustainable economic innovations	x					
10. sustainable product design	x	x				
12. circular economy	x			x	x	
13. polluter pays principle	x					
14. sustainable consumption		x		x		
17. indicators		x				
20. fair working conditions and health and safety	x		x			
27. rule of law				x	x	x
28. targeted legislation				x	x	x
29. effective enforcement				x	x	x

x = not relevant

As obtained from Table 6-7, GE criteria such as reduction of waste, reuse and recycling, renewable raw materials, sustainable economic innovations, sustainable product design, circular economy, polluter pays principle, fair working conditions, and health and safety are of minor importance for activities in the topic area of E&H.

The project team considers the focus and area of responsibility of the topic area to be the reason for that as the activities are primarily related to research and prevention of negative impacts on health. Specific regulations and measures for substances and products, changes in process and management as well as the assignment of responsibilities for organisational and financial issues are traditionally in the area of competence of other BMUB and UBA sectors, and the BMAS is responsible for workers safety.

Chemical Safety and Sustainable Chemistry

Within the topic area of CS, GE criteria like resource efficiency, energy efficiency, reduction of waste, reuse and recycling, circular economy, renewable raw materials, climate protection, sustainable product design, sustainable consumption, and indicators are classified as not relevant for this evaluation. This is because, in the project team’s opinion, they are beyond the classical understanding of CS and rather refer to the topic area of SC. An additional reason for this evaluation was the overlap between both

topic areas and the fact that important political activities and regulations cover both topic areas. For a better differentiation, we decided to assess systematic GE criteria with dominating sustainability aspects under SC and to include the criteria regarding exposure at work solely to the topic area of CS.

Voluntary Activities

According to the project team’s assessment, criteria such as the rule of law, targeted legislation, and effective enforcement are not within the focus of voluntary industrial initiatives, incentives, funding programmes, and similar measures. In addition, the private sector has no ability to establish mandatory regulation. Thus, these criteria were not considered during the evaluation, but beyond that, they were equally relevant like the respective political initiatives.

Only in the topic area of E&H, we made a slightly different choice due to the small amount of assessed voluntary activities and their specific scopes (*LRI*, cooperation for the development of new HBM biomarkers and analysis methods, and the *INTARESE* research project in cooperation with Cefic). The GE criteria of sustainable economic innovations, sustainable product design, fair working conditions, and health and safety are excluded, whereas climate protection was considered not relevant.

7 Proposals of Possible Contributions to the Green Economy Discussion

The following chapter presents specific proposals, which are based on the summarising evaluation of the analysis in chapter 6. This involves the potential contributions of the topic areas SC, CS, and E&H to support the GE discussion and asks the question of how those three topic areas can be adjusted more appropriately to the requirements of a GE. The recommendations are addressed to policy and other stakeholders of the chemical sector, such as industrial associations and enterprises.

The recommendations shall provide a basis for discussions and future measures of the national, European, and international chemicals policy as well as for the international chemicals management.

Where possible, proposals are specified regarding an operational implementation and formulated as options of action including supporting arguments in order to facilitate a targeted and feasible integration of the three topic areas E&H, SC, and CS to a GE.

The proposals give answers to the following questions:

1. How can the chemical sector be embedded more strongly into a GE? How can the use of the efforts in the three topic areas for a GE be better communicated and illustrated?
2. Where are the biggest challenges with respect to GE in the chemical sector? What specifically has to be done in order to achieve the goals of a GE?

Furthermore, the proposals give answers to the questions arising within the frame of the German GE discussions:

3. How can harmful emissions and pollutions into the environment be prevented?
4. How can a more efficient use of energy, raw materials, and other natural resources be achieved?
5. How can one act in accordance with nature and environment by maintaining and restoring biological diversity as well as ecosystems and their services?
6. How can qualitative growth be decoupled from natural resource depletion?
7. How shall legislation and organisation of the framework requirements be configured so that resource efficiency and enhancement of a GE would be supported and that investments and innovations would be promoted?
8. Which incentives shall be provided for sustainable (economic) behaviour?

9. How can the overall approach of GE be anchored in economy and society (e.g. by promoting environmental awareness)?
10. Which consulting and promoting instruments are required to encourage and support a faster transfer towards a GE?
11. How can a successful transformation in Germany and Europe occur under the conditions of international competition for investments, products, and services?
12. How can green value-added potentials be implemented in Germany and worldwide?
13. How are good company strategies as well as good business and financing models characterised?
14. How can German jobs be secured with a GE?

Insufficient answers were identified during the analysis of the existing activities for the following questions:

15. How can costs and risks of transformation be kept as low as possible?
16. How can the transformation be designed in a socially fair manner?

7.1 Detailed Proposals for Stakeholders of State, Associations, and Companies

As criteria such as closed material cycles and a special emphasis on renewable resources are only parts of the German definition of GE, we recommend implementing these aspects into the European and international discussions as a national contribution.

This is also true for the criteria precautionary principle, durability of products, and environmental sinks regarding the definition of SC. Here, a request for bringing these aspects into the international discussions is recommended as well.

7.1.1 Proposal 1: Promotion of the Integration of Laws and Regulations for a Broader Coverage of Green Economy Criteria

Target Group: Political Decision-Makers

Background: As a legal basis for the chemical industry, *REACH* represents a high level of integration (many single laws and regulations combined into one consistent regulation). Thus, it allows a simultaneous addressing of ecophysical, social, and political GE criteria (see appendix II of the German report). Moreover, the integrative approach of *REACH* offers great advantages with respect to obligation and reliability as well as the reduction of arbitrary acts. Disadvantages include the high costs and the administrative effort, which has to be considered regarding economic

efficiency and global fairness.

Overall, it has to be emphasised that a corresponding integrative approach is also recommendable for other aspects of a GE.

As it is difficult from a legal point of view to create integrative GE rules in Germany due to the traditional sectoral and non-integrative regulatory approach (e.g. waste, chemicals, plant protection products, rules on the environmental compartments), we suggest to BMUB and its associate authorities to work towards the implementation of integrating GE rules on the European level in a first step because of the usually integrative approach of European law. Generally, it is desirable at the national level to achieve harmonisation of the regulations and transfer of the strong integrative approach in the long run. This could be fostered by European regulations. However, abandoning exemplary national accomplishment for the benefit of a European compromise must be avoided.

7.1.2 Proposal 2: Intensified Utilisation and Transfer of the Chemical Sector's Established Mechanisms on the International Transfer of Knowledge for the Implementation of a Green Economy

Target Group: Political Decision-Makers, Associations

Background: In the chemical industry, mechanisms and platforms for international transfer of knowledge were established within the frame of sustainability initiatives and efforts for the improvement of CS on both the public (e.g. *REACH, US EPA, INCHEM, WHO Risk Assessment Network*) and the industrial sector (e.g. ICCA). These measures significantly increase the transparency about risks, ways of exposure, and measures for risk minimisation. A transfer of these mechanisms to other industrial sectors would support the increase of the sustainability performance of the entire economy.

In order to be used efficiently and globally, a GE information platform should be linked to additional global programmes on the improvement in education on sustainability and CS. This contains the basic principles of sustainability, knowledge about toxicology and risk assessment as well as information about options of risk management. Regarding the experience with safety standards and expertise about risks and sustainability in emerging and developing countries, it also seems essential to develop easily accessible information as well as expert knowledge, which can be used in these countries as an initial orientation. As the co-existence of information platforms implies uncoordinated communication and evaluation, efforts for harmonising the information instruments and contents should be undertaken at the different political levels.

Therefore, we recommend to the BMUB and its associate authorities to transfer the principle of international information platforms about

CS and SC in cooperation with the VCI to the establishment of a platform for information and exchange of knowledge about GE. For example, experiences that were made with competing co-existing platforms in the chemical sector should be used. Potential umbrella organisations for such a platform would include the United Nations (*Agenda 21*) or the OECD. Alternatively, contents of existing platforms (national, NGO, industrial) should at least be harmonised and, comparable information platforms should be linked to each other directly to ensure a global coordination and communication of uniform contents.

Furthermore, we recommend to the BMUB and its associated authorities to introduce experiences from the German industry into the development of activities that are target group-oriented and that could also utilise the models and tools within the CS topic area that are currently under development. This should be achieved in close collaboration with GIZ, VCI, and other industrial associations (BDI). In terms of the global utilisation, we recommend improving targeted activities and international education programmes on sustainability and CS in developing and emerging countries by introducing the knowledge gained in Germany. The *Memorandum of Understanding (MoU)* between ICCA and UNEP and the resulting special programmes of UNEP for the generation of sustainable national structures (e.g. harbour and transport authorities) constitute good examples.

The BMUB could increase the contributions towards the aspects of sustainability into international education and training programmes (e.g. UNEP *CAPP*, UNEP *Responsible Production*, UNEP Eco-innovation manuals, UNIDO *ChL*, UNIDO Innovative Chemical Solutions, GIZ training programmes). This would directly anchor the knowledge of German sustainability processes, efficiency agencies, and the chemical industry in the programmes.

7.1.3 Proposal 3: Transfer of Existing Communication Experiences for the Effective Implementation of a Green Economy

Target Group: Political Decision-Makers, Companies

Background: In the topic area of SC/CS, the obligation for communication along the supply chain of chemicals under *REACH* is a unique demonstration of responsible production in Europe. This increased the general transparency and strengthened the position of consumers for goods and services decisively. A systematically improved and more transparent communication along the supply chain would also contribute to customer’s and consumer’s possibilities to exercise influence and thus to improve the sustainable consumption and production.

Besides *REACH*, other programmes including obligations for communication, like the *Basel Convention*, the European regulation on transboundary transports of waste, the existing ecolabel, ideas on the *Environmental Footprint* as well as voluntary product responsibility and environmental management schemes (*ISO*, *EMAS*) or sustainability report regulations (*GRI*, etc.), may be utilized as examples. This can include reports about energy and raw materials, sustainable raw materials extraction, social standards and working conditions, environmental management systems, applications and ways of disposal including information on climatic effects, risks of emissions, or recycling possibilities.

To some extent, this has already been implemented on the national level with the establishment of the *German Sustainability Code* by the German Council for Sustainable Development. This already considered the aspect of including a transparent communication of the funding practice of financial service providers according to sustainability criteria.

This recommendation shall be used as a chance to harmonise, integrate, and oblige the large number of existing approaches on sustainability communication. This homogeneity and obligation also represent the special contribution of the chemical sector, which, in comparison to other approaches, serves as a role model.

Thus, we recommend to the BMUB and its associated authorities to introduce the special experiences of the chemical sector concerning advantages, disadvantages, and possibilities of the implementation of uniform and obligatory report requirements along the supply chain into the ongoing discussion on the national, European and international level. This is particularly true for the current CSR discussion. An essential goal should be better arranging the large number of information, which is already transmitted along the supply chain, according to the requirements of the target groups. Chemical associations and companies should introduce especially their valuable experiences regarding the practical application and implementation of communication systems and should contribute to identify the most appropriate systems for a GE.

7.1.4 Proposal 4: Transfer of Experiences Regarding the Advantages of International Conventions and their Interconnectedness to the Green Economy

Target Group: Political Decision-Makers

Background: In the chemical industry, international conventions with relatively strict requirements and clear rules, e.g. the *Basel, Rotterdam, and Stockholm Conventions* or the *Montreal Protocol*, have a comparatively high importance. By the obligations to implement the conventions into national laws and action plans and to introduce

measures for risk minimisation that accompany the ratification of the conventions, all member states are obliged to put improvements into practice. Synergy processes between the conventions were increasingly implemented during the last years. This resulted in better risk recordings and eased the design of the control measures along the product life cycle. The voluntary approach *SAICM* moves into the same direction after the request of the second follow-up conference for a stronger integration of the WHO (*PHE, IPCS*).

Work programmes, indicators of progress, *SAICM* incentive systems, obligations for reports and inventories as well as annual review committees with a clear mandate request the cooperation of the member states and lead to more justice, conservation, and health protection by harmonising the standards (including global bans or restrictions of substances). International cooperation and transfer of knowledge are simplified at the same time by these interconnected regulation systems.

These tasks and goals might best be achieved via an international organisation that possesses the necessary mechanisms and responsibility for a harmonisation as well as the experience in the field of method development for the implementation and, if necessary, also has possibilities of sanctions in order to control and enforce the adherence of guidelines and targets. The transfer of *GHS* requirements into the EU *CLP regulation* is a positive example of a good integration of an initiative into several levels.

For the enhancement of GE, we propose to the BMUB and its associated authorities to introduce the experiences gained from synergies between conventions about chemical safety in national and European discussions as an example for special contributions towards global fairness. We also recommend to work towards the global adaptation of *GHS* requirements following European standards in the international discussion processes in order to achieve comparable standards in the medium and long term.

7.1.5 Proposal 5: Upscaling of Selected Voluntary Sustainable Chemistry Initiatives Concerning Chemicals to Non-Chemical Products and Services

Target Group: Political Decision-Makers, Associations, Companies

Background: The discussion about sustainability has a long tradition in the chemical industry. The combination of legal measures and industry initiatives led to the fact that many GE criteria are already fulfilled.

With *Responsible Care* [ICCA 2014], the chemical industry developed an instrument that helps companies improving their performance concerning environment, safety, and health constantly and committing themselves simultaneously to efficient resource use, waste and

emissions reduction as well as substitution. Therefore, the network provides information, checklists, and indicators. For a global and transparent communication, progresses are published under *Responsible Care*. The charter commits to the implementation and solution of the following targets and challenges: sustainable development, effective chemicals management, increased transparency of the industry, and a global harmonisation of the measures within the network. Different areas of the world are committed to these specific targets of implementation because of the global network and cooperation with governmental agencies. This intersectoral approach differentiates *Responsible Care* from certification systems such as *Fair Trade, Blue Angel, EU ecolabel, FSC, MSC*, etc.

Upscaling of these global networks of special industrial sectors to other industrial and societal areas could lead to synergies due to the experiences with these networks. The advantage of such a voluntary approach would be that the compliance with GE criteria, transfer of knowledge, and training would not need to be enforced by regulatory measures and be under governmental control, which could reduce the workload for the legislative authority, accelerate implementation, and promote practical and economically beneficial solutions.

For an effective implementation and achievement of goals (prevent green washing), such networks could coordinate and further develop their criteria in cooperation with the competent authorities, ensure harmonised reporting and to allow for a third party verification of reported results.

We therefore propose to the political decision-makers and associations on the national, European, and international levels to foster an increased and broader transfer and an implementation of existing voluntary initiatives into the daily industrial practice with the help of a close cooperation with other ministries and associations.

Furthermore, they should support other industrial sectors (manufacturing industry, commercial and financial industry) in adopting and learning from sustainability initiatives of the chemical industry by setting an appropriate political framework.

Options include a *Responsible Care* initiative for financial products and *Responsible Care* for the manufacturing industry, for retail and wholesale, transport, waste management, healthcare, welfare systems, and for consumers. Another example would be the *Sustainability Index* and the *Total Cost Assessment Tool* of AIChE.

In addition, we recommend to the companies and associations of the chemical industry to intensify the exchange with other sustainability initiatives at the national, European and

international levels (e.g. *Blue Competence,* the sustainability initiative of the Verband Deutscher Maschinen- und Anlagenbau (VDMA), a German engineering association) as well as to intensify the cooperation among the members (supplier/consumer) and authorities to achieve an optimal prioritisation and connection of different key aspects with respect to a GE. Such cooperation could start at the national level but should eventually be incorporated also at the European and international level.

An additional approach for the implementation of GE criteria, such as an absolute minimisation of the raw materials demand, is the use of innovative service concepts like *ChL* (chapter 4.3.1). Here, profits are no longer coupled to the sold quantities of the product in the supply chain but are dependent on a benefit-oriented approach. As the idea of leasing is not specific to the chemical sector, it can in principle be transferred to all constellations of suppliers and users in the manufacturing and processing industry, in agriculture, and in recycling, as long as emissions and material losses shall be minimised by optimisation of the production process. Thus, we recommend to the BMUB and its associated authorities to promote the idea of ecoleasing or to establish new business models that are service-oriented or beneficial to the community. Concepts such as *ChL* or *Chemicals Management Systems* or *Cost per unit System* can serve as a role model here. In order to broadly establish these innovative ideas and raise awareness concerning the advantages, it is recommended to intensify the public relations work with respect to a GE on all levels (politics, associations, efficiency agencies). We recommend to the associations and companies to more strongly implement these approaches.

7.1.6 Proposal 6: Promotion of Measures for the Prevention of Accidents as a Key Element of Humane Working Conditions and Human Rights

Target Group: Political Decision-Makers, Associations, Companies, Trade Unions

Background: The current definition of GE is generally targeted at the improvement of human well-being, poverty alleviation, and decent working conditions. In this context, activities regarding the prevention of accidents are a good contribution to the GE discussions about decent working conditions, nature conservation, and the quality of life.

Safe chemicals management of *SAICM* aims at nature conservation, the promotion of human health, and the reduction of risks at work. Accordingly, *REACH* defines that chemicals must only be produced and utilised if their safe use can be proven. *GHS* and the *CLP regulation* facilitate the prevention of industrial and domestic accidents with chemicals by the requirements for labels and threshold values for

exposition at the workplace. Examples of the high level of European health and safety measures for the chemical sector are the *Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at* work and the *Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work*. An additional important European example for the prevention of chemicals accidents is the *Seveso* directive (chapter 4.2.6).

Instruments and measures that can be particularly transferred from the chemical sector to GE discussion include UNEP activities on CS, such as *Responsible Production*, *APELL*, or the *Flexible Framework* initiative. Furthermore, the *Human Health Risk Assessment Toolkit* (chapter 4.3.1), the *Integrated Risk Assessment,* and the *Chemical Risk Assessment Network* (chapter 4.2.1) as well as the OECD *CoCap* Programme (see chapter 4.2.1.) should be mentioned. German activities are the *EMKG* of the BAuA or the *GDA*. The latter is an example for an approach with emphasis on participation but is not specific to chemicals (see chapter 4.2.3). Voluntary regulations on health and safety connected to chemicals management are represented by *GPS, Responsible Care*, or substance-related initiatives such as *NEPSI*.

While industrialised nations have very effective legal regulations for the prevention of accidents, these guidelines are often lacking in emerging and developing countries. To some extent, this is a matter of legislation; however, a more common problem is the lack of enforcement due to missing expertise and experience with control mechanisms. It is also important to create sensitivity for this topic with regard to workers’ rights. The awareness for the entitlement of health and safety are as important as risk awareness. To facilitate this, authorities, employers, and employees have to be involved.

With respect to global fairness as a central element of GE, we recommend to strengthen the efforts for a global harmonisation of legal requirements, standards of enforcement, and safety at the workplace. For instance, the BMUB and its associated authorities could, in cooperation with the BMAS and the BAuA, introduce the topic as a general objective into the GE discussion. On the other hand, we see considerable potential for the promotion of measures of accident prevention at the workplace by raising awareness, education, labelling, and adjustments of processes at the national and European but especially at the international level. Here, the BMUB with its associated authorities, in possible collaboration with BMAS and BMZ, and the chemical industry can directly or indirectly improve health and safety along the supply chain by in-house or sector-related standards. Furthermore, they can support

international programmes with good practice examples or the provisions of experts.

8 Proposals for Measures Needed to Establish a Green Economy in the Topic Areas of Environment and Health, Chemical Safety, and Sustainable Chemistry

Based on the results of the analysis, this chapter introduces measures that are still required for the establishment of a GE in the three topic areas. Besides the preceding steps, results of the research and development programme “Assistenz bei der Evaluierung von Strategien zur CS und Weiterentwicklung einer NC in Deutschland” (see chapter 4.3.3) are considered. The recommendations are substantiated with respect to their operational implementation if possible. Therefore, they contribute to a future, targeted, and practical integration of the three topic areas E&H, CS, and SC into a GE.

8.1 Detailed Proposals for Political Decision-Makers, Associations, and Companies

8.1.1 Proposal 7: Strengthening of Obligations and Efficiency of International Initiatives on Sustainable Chemistry

Target Group: Political Decision-Makers

Background: Due to *REACH* and *IED* regulations, Europe has achieved a level of sustainability requirements, which is not comparable to that from any other part of the world. With regard to *SAICM* and programmes established in the *SAICM* and *Agenda 21* context, many criteria defining a GE are already anchored on the international level. However, these potentials are so far rarely used because of the missing obligations and the implementation difficulties. At the same time, the globalisation of production leads to increasing risks of distortion of competition and in environment and health due to low environmental, social, and health and safety standards in emerging and developing countries.

Keeping this in mind, we recommend to the BMUB and its associated authorities to advocate the strengthening of *SAICM* obligations and areas of influence and to promote the establishment of the respective structures for this development. To make *SAICM* legally binding, it could be attributed with a convention status, similar to that of the *Basel, Stockholm* and *Rotterdam Convention* or the *Montreal Protocol* and the *Minamata Convention.* Such a proposal (including the respective structural changes of the existing secretariat’s mandate) could be prepared for the ICCM 4.

8.1.2 Proposal 8: Improvement of the Boundary Conditions for Substitution and Innovation

Target Group: Political Decision-Makers

Background: Substitutions of hazardous chemical substances and innovations have great significance in Europe due to the legal frame

of *REACH*. In addition, this aspect is mentioned explicitly in the criteria of the UBA/OECD Workshop and in the *Guide on Sustainable Chemicals*. Strategies on sustainability, resource efficiency, and technology development aim at sustainable innovations concerning the substitution of fossil resources. Furthermore, associations, governments, and international organisations (e.g. *US-EPA, BMBF, UNEP*) established manifold incentives in form of awards or funding programmes, which sometimes are directly related to the chemical industry. However, the rate of substitution is sometimes difficult, which can be seen in examples such as the *Stockholm Convention*, the European Community strategy for endocrine disrupters [EU COM 1999], and REACH (see chapter 6.2.3). With respect to renewable raw materials or the entire resource or energy demand, there are also deficits in the implementation of the requirements, such as those in the German Sustainability Strategy. This is especially true for SMEs (see chapter 6.2.4). In addition, different experts perceive the lack of knowledge about resource demands as an important factor that hinders innovations (see e.g. chapter 4.3.3.)

We recommend an improved communication concerning the economic benefits of innovations for a single company and consider this to be an important incentive for more innovations especially in SMEs. Moreover, information and instruments for the determination of the resource demand have to be provided. It would also be important to enhance the knowledge about potential alternatives, in particular among product designers and consumers. The agencies established by the federal government (*DEMEA, DERA, VDI-ZRE*) could help to implement activities for these purposes.

A second option in order to foster innovations would be the financial incentives in form of funding for efficient raw materials use, voluntary substitution, or innovative process technologies. Support by means of GE criteria could be an important incentive for the industry and could thus represent a political control instrument as well. Governments and international decision-makers could consider and evaluate GE components in funding requests as a bonus. However, a prerequisite would be the definition of a benchmark (measurable criteria see recommendation 10) and the possibility of a holistic sustainability assessment, which comprises all target systems.

In this context, we recommend to the BMUB and its associated authorities to promote and enhance sustainability criteria for innovations funding in the chemical industry in close collaboration with other ministries and the financial sector. The *German Sustainability Code* is a possible basis for reports about non-financial performance indicators of enterprises and for the targeted embedding of the financial sector into the funding of sustainability

(see chapter 5.7).

It should be controlled on the legislative level as to which extent the transfer of innovation obligations, besides the existing substitution requirements of *REACH*, could be introduced. Hazardness and efficiency of chemicals should be taken into consideration as well as market requirements. The requirements of the new *Plant Protection Products Regulation (EC) No. 1107/2009* serve as an example as they define precise rules and procedures for substitution of relatively dangerous or inefficient pesticides.

For all measures, it has to be kept in mind that substitution should not and must not be the ends in themselves but serve as means for the achievement of objectives, e.g. a higher creation of value or a reduced risk.

In this context, we recommend the additional enhancement of suitable criteria and assessment systems for sustainable innovation as essential funding instruments for innovation. This should be done by the BMUB in close cooperation with its associated authorities, other associations, and NGOs (see proposal 10 in chapter 8.1.4).

8.1.3 Proposal 9: Upscaling of Sustainability Initiatives of the Chemical Sector to All Companies and Associated Production Chains

Target Group: Associations, Companies, (Political Decision-Makers)

Background: Bearing the concept of life cycle considerations in mind, the international, European, and national chemical industries already fulfil many GE criteria particularly within the production processes, and several initiatives either demand or promote sustainability. However, not enough attention has been given to downstream industries (processing, application, disposal) at the moment. Furthermore, there is evidence for the need of improvement regarding resource efficiency and sustainability (durability, recyclability etc.) during the value creation from existing and already produced goods. In terms of a GE, the sustainability of products is an important element for the reduction of environmental risks, resource scarcity, land consumption, GHGs, use of primary raw materials, and the burden of ecosystems as well as for the improvements of recycling systems and closed materials cycles and of the sustainable design of consumption. In order to achieve improvements, information and valuation standards are required.

For further greening of the chemical industry, it is important that associations and enterprises implement the control and assessment of sustainability criteria and expand them to the products of the chemical industry. This is already partly done by the large chemical companies and sustainability initiatives for the production process. Therefore, sustainability reports using accepted reporting systems (see chapters 5.3 and 4.3.6) in particular are desirable throughout the sector. According to our evaluation and regarding feasibility, a sustainability estimation as proposed by the *Guide on Sustainable Chemicals* is suitable for the sustainability assessment of products. Another possible example is the *Sustainability Manual* and the sustainability life cycle analysis of the NGO *TNS*. Established certification systems for products, like *Blue Angel, EU ecolabel, FSC,* or *Fair Trade*, might be too extensive and costly for the implementation throughout sectors such as the chemical industry with hundreds of different products.

In order to establish comparable standards, minimise the administrative work, increase comparability, and avoid similar systems and inconsistencies, we recommend to the BMUB and its associated authorities to identify feasible systems and criteria in close collaboration with the associations and NGOs (see recommendation 10).

As a programme for a global implementation of reporting chemicals in products, UNEP's *CiP* seems suitable as it develops and comprises

guidelines for an appropriate reporting from producers to users, including political decision-makers, consumers, and NGOs.

8.1.4 Proposal 10: Development of Green Economy Indicators for the Chemical Industry for the Targeted Promotion of Innovation and Improved Evaluation of Sustainability

Target Group: Political Decision-Makers, Associations, Companies

Background: Innovations and the willingness to innovate towards a SC are complicated by the fact that no clearly defined objectives exist in the topic area of SC and that trade-offs between the different priorities have to be made (e.g. energy, raw materials, danger, waste). The development of sustainability is also hindered by the existing uncertainty within the definition of the resource term and the provision of appropriate methods for quantification. The chemical industry currently faces various conflicting objectives because of the production of resource-intensive goods, which might in turn have positive effects with respect to the GE development. A clear definition of priorities and evaluation possibilities is therefore of high concern (see e.g. chapter 5.4 and chapter 4.3.3, *Guide on Sustainable Chemicals*).

In order to better embed the chemical industry into a GE, it is essential to structure, operationalise, and quantify the priorities for the chemical sector in terms of a GE. This should be achieved in close cooperation between politics, sustainability agencies (VDI-ZRE, DEMA, DERA, etc.), the chemical industry, suppliers of technology, and research institutes. Subsequently, it should be the aim to target instruments for funding and support to these priorities.

Therefore, we suggest an accelerated development of indicators for the chemical industry with respect to a GE. This should be elaborated in close cooperation among all political, industrial, and societal stakeholders.

Amongst others, the recommendations of the research programme “Assistenz bei der Evaluierung von Strategien zur Chemiekaliensicherheit und Weiterentwicklung einer nachhaltigen Chemie in Deutschland” (see chapter 4.3.3) provide a basis for the development of criteria. In addition, the GE criteria developed in this project can be used for a differentiation of the existing indicators, which is adjusted according to the needs of the chemical sector. Results of a VDI ZRE-commissioned project, which tested the practical feasibility of the VDI guidelines to calculate the resource efficiency, can also be used for this purpose. Furthermore, we recommend to test the applicability of criteria of international and national sustainability-reporting systems and sustainability indices (see chapters 5.3 and 4.3.6) for the chemical industry and,

to harmonise these criteria, if possible. Examples include the *GRI*, the *German Sustainability Code*, sustainability indices of international financial instruments, the sustainability life cycle analysis of TNS, and the evaluation instruments of AIChE.

9 Abbreviations

ACS GCI	American Chemical Society Green Chemistry Institute
A.I.S.E	International Association for Soaps, Detergents and Maintenance Products
AfDB	African Development Bank
AIChE	American Institute of Chemical Engineers
APELL	Awareness and Preparedness for Emergencies at Local Level (UNEP Programme)
APUG	German Environment and Health Action Programme (Aktionsprogramm Umwelt und Gesundheit)
ArbSchG	Occupational Safety and Health Act
ASiG	Occupational Safety Act
BAT	best available technique
BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin
BAVC	Employers' Federation for the Chemical Industry
BDA	German Employers' Association
BDI	Federation of German Industry
BEP	Best environmental practice
BfN	Federal Agency for Nature Conservation
BfS	Federal Agency for Radiation Protection
BfR	Federal Institute for Risk AssessmentBImSchG Federal Immission Control Act
BImSchV	Ordinance for the Implementation of the Federal Immission Control Act
BMAS	Federal Ministry of Labour and Social Affairs
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMG	Federal Ministry of Health
BMUB	Federal Ministry of the Environment, Nature Conservation, Building and Nuclear Safety
BMWi	Federal Ministry of Economic Affairs and Energy
BMZ	Federal Ministry for Economic Cooperation and Development
BSEF	Bromine Science and Environmental Forum
Cefic	European Chemical Industry Council
CEHAPE	Children’s Environment and Health Action Plan for Europe
ChemG	German Chemicals Act (Chemikaliengesetz)
ChL	Chemical Leasing

CICAD	Concise International Chemical Assessment Documents
CiP	Chemicals in Products project (UNEP)
CLP	Classification, Labelling and Packaging of Substances and Mixtures
CMR	carcinogenic, mutagenic or toxic for reproduction substances
CoCAP	Cooperative Chemicals Assessment Programme (OECD)
COPHES	Consortium to Perform Human Biomonitoring on a European Scale
COST	European Cooperation in Science and Technology
CSB	OECD Programme Chemical safety and biosafety
CSCP	Center on Sustainable Consumption and Production
CSDS	Collaborative Standards Development System
CSR	Corporate Social Responsibility
DBU	German Federal Foundation for the Environment
DECHEMA	Society for Chemical Engineering and Biotechnology
Defra	Department for Environment, Food and Rural Affairs
DERA	German Mineral Resources Agency
DGB	German Confederation of Trade Unions
DIHK	Association of German Chambers of Commerce and Industry
DJSI	DOW Jones Sustainability Index
DEMEA	German Agency for Material Efficiency
DENA	German Energy Agency
DNK	German Sustainability Code
DNP	National German Sustainability Award (Deutscher Nachhaltigkeitspreis)
DNR	German League for Nature, Animal Protection and Environment
DüMV	Fertiliser Ordinance
EAP	Environment Action Programme
ECHA	European Chemicals Agency
ECEH	European Center for Environment and Health
ECHI	European Core Health Indicators
EEA	European Environment Agency
ERA	European Research Area
EFRA	European Flame Retardant Association
EFFAS	European Federation of Financial Analysts Societies
EHAPE	Environmental Health Action Plan for Europe
EHC	Environmental Health Criteria

EHMB	European Environment and Health Ministerial Board
EHP	European environment and health process
EHS	OECD Programme Environment, health and safety
ElektroStoffV	Ordinance on the restriction of the use of certain hazardous substances in electrical and electronic equipment
EMA	European Medicines Agency
EMAS	Eco-Management Audit Scheme
EMKG	The easy-to-use workplace control scheme for hazardous substances
ENHIS	Environment and Health Information System
EPA	Environmental Protection Agency
EPP	Environmental Preferable Purchasing
E-PRTR	European Pollutant Release and Transfer Register
EREP	European Resource Efficiency Platform
ESAB	European Section on Applied Biocatalysis
ESBIO	Expert team to support Biomonitoring in Europe
ESDN	European Sustainable Development Network
EU ETS	European Emissions Trading System
EU	European Union
EuCheMS	European Association for Chemical and Molecular Sciences
EuropaBio	European Association for Bioindustries
FAO	Food and Agriculture Organization of the UN
FKZ	Project Code Number (Forschungskennzahl)
FNG	Industry Association for Sustainable Investment (Forum Nachhaltige Geldanlagen)
FONA	Framework Programme Research for Sustainable Development
FP	Framework Programmes for Research and Technological Development
GCP	Good Clinical Practice
GDA	Joint German Occupational Safety and Health Initiative (Die Gemeinsame Deutsche Arbeitsschutzstrategie)
GDCh	German Chemical Society
GE	Green Economy
GefStoffV	German Ordinance on Hazardous Substances
GEI	Green Economy Initiative (UNEP)
GerES	German Environmental Survey
GG	Green Growth

GGKP	Green Growth Knowledge Platform
GHS	Globally Harmonised System
GII	Green Industry Initiative
GIZ	German Society for International (Deutsche Gesellschaft für internationale Zusammenarbeit)
Global PSC	Global Product Stewardship Council
GP	Greenpeace
GPA	Global Plan of Action
GPP	Green Public Procurement
GPS	Global Product Strategy
Green ChemEx	Green Chemistry Resource Exchange
GRI	Global reporting initiative
HBM	Humanbiomonitoring
Heidi	Health in Europe: Information and Data Interface
HPDB	Household Product Database
ICCA	International Council of chemical associations
ICCM	International Conference on Chemicals Management
ICSC	International Chemical Safety Cards
IE	Industrial Ecology (UNEP)
IED	Industrial Emissions Directive
IEHIAS	Integrated Environmental Health Impact Assessment System
IFC	International Finance Corporation
IFCS	Intergovernmental Forum on Chemical Safety
Ifeu	Institute for Energy and Environmental Research (Institut für Energie- und Umweltforschung)
IFOAM	International Federation of Organic Agriculture Movements
IfS	Institute for Sustainability
IG BCE	German Trade Union Mining, Chemical and Energy Industries (Industriegewerkschaft Bergbau, Chemie, Energie)
ILO	International Labour Organization
IMF	International Monetary Fund
INTARESE	Integrated Assessment of Health Risks of Environmental Stressors in Europe
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
IPCS	International Programm on Chemical Safety

IPEEC	International Partnership for Energy Efficiency Cooperation
IPP	Integrated Product Policy
IRK	Indoor Air Hygiene Commission
ISO	International Organization for Standardization
JPOI	Johannesburg Plan of Implementation
KfW	Reconstruction Credit Institute (Kreditanstalt für Wiederaufbau)
KiGGS	Study on the health of children and adolescents in Germany (Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland)
KRU	Resources Commission at the Federal Environment Agency
KUS	Environmental Survey for Children (Kinder Umwelt-Survey)
LRI	ICCA Long-range Research Initiative
LRTAP	Long-Range Transboundary Air Pollution Convention
MKULNV	Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia (Ministeriums für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz Nordrhein-Westfalen)
NEHAP	National Environment and Health Action Plans
NEPSI	European Network on Silica
NGO	Non-governmental Organization
NHANES	National Health and Nutrition Examination Survey
NRP	German National Reform Programme (Deutsche, nationale Reformprogramme)
OECD	Organisation for Economic Cooperation and Development
OPS	Overarching Policy Strategy
PAH	polycyclic aromatic hydrocarbons
PBT	persistent, bioaccumulative and toxic substances
PDS	Pesticide Data Sheets
PFCs	perfluorinated compounds
PflSchG	Plant Protection Act (Gesetz zum Schutz der Kulturpflanzen)
PHE	Global Strategy on Public Health and Environment
PI	Process Intensification
PIC	Prior Informed Consent
POPs	persistent organic pollutants
PROSA	Product Sustainability Assessment Guideline

PRTR	Sustainable Chemicals Platform (OECD)
QSP	Quick Start Programme
R&D	research and development
RAN	WHO Chemical Risk Assessment Network
REACH	Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals
RECP	Resource Efficient and Cleaner Production
RECPnet	Global Network for Resource Efficient and Cleaner Production
RKI	Robert Koch Institute
RoHS	Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment
RSC	UK Royal Society of Chemistry
SAICM	Strategic Approach to International Chemicals Management
SCN	Sustainable Chemistry Network
SCP	EU Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan
SDG	sustainable development goals
SDS	safety data sheet
SEA	socio-economic analysis
SIDS	Screening Information Data Set
SubChem	Sustainable substitution of hazardous chemicals
SusChem	European Technology Platform for Sustainable Chemistry
SusCon	International Conference on Sustainable Business and Consumption
SVHC	Substances of Very High Concerne
SWITCH	EU sustainable consumption and production promotion programme
TCA	Total Cost Assessment
TJ	Terajoule
TNS	The Natural Steps
TTIP	Transatlantic Trade and Investment Partnership
UBA	German Federal Environment Agency (Umweltbundesamt)
UFOPLAN	Environmental Research Plan (Umweltforschungsplan)
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Conference on Sustainable Development
UNCTAD	United Nations Conference on Trade and Development

UN DESA	United Nations Department of Economic and Social Affairs
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UPB	German Environmental Specimen Bank (Umweltprobenbank des Bundes)
VCI	German Chemical Industry Association (Verband der Chemischen Industrie)
VDI	Association of German Engineers (Verein Deutscher Ingenieure)
VDI-ZRE	The centre for resource efficiency of the Association of German Engineers (Zentrum für Ressourceneffizienz des Vereins Deutscher Ingenieure)
VECAP	Voluntary Emissions Control Action Programme
VFU	Association for environmental management and sustainability in finance institutes e.V. (Verein für Umweltmanagement und Nachhaltigkeit in Finanzinstituten)
VOC	volatile organic compound
WEEE	waste electrical and electronic equipment
WHG	Federal Water Act (Wasserhaushaltsgesetz)
WHO	World Health Organisation
WHO/ECEH	WHO European Center for Environment and Health
WRMG	Detergents and Cleaning Products Act (Gesetz über die Umweltverträglichkeit von Wasch- und Reinigungsmitteln)
WTO	World Trade Organization
ZIM	Central Innovation Programme for Small and Medium Enterprises

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