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Sustainability initiatives and approaches in the chemical sector

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Sustainability initiatives and approaches in the chemical sector

by

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Abstract

To allow the ISC_3 a quick start to its substantive work, the clients (UBA/BMUB) have commissioned the drafting of three studies. The objective of this study was to create a knowledge base by mapping the most relevant initiatives/approaches in the field of sustainable chemistry. For this purpose, the following sectors were examined: Green chemistry (n = 8), international organizations (2), (chemical) industry approaches (5), approaches from the upstream/downstream value chain (3), approaches at company level (6), approaches in sustainability reporting, sustainability rating and socially responsible investment (4), approaches from further non-governmental/non-profit organisations (NGOs/NPOs) (1), and research approaches (1). Gaps were identified and recommendations for the future work of the ISC_3 were derived.

Kurzbeschreibung

Um dem ISC_3 einen schnellen Einstieg in die fachliche Arbeit zu ermöglichen, haben die Auftraggeber (UBA/BMUB) die Erstellung dreier Studien beauftragt. Das Ziel dieser Studie war die Schaffung einer Wissensbasis in Form einer Darstellung der wichtigsten Initiativen/Ansätze im Bereich der nachhaltigen Chemie. Zu diesem Zweck wurden folgende Sektoren analysiert: Grüne Chemie (n = 8), internationale Organisationen (2), Ansätze der (chemischen) Industrie (5), Ansätze aus der vorgelagerten / nachgelagerten Wertschöpfungskette (3), Ansätze einzelner Unternehmen (6), Ansätze aus der Nachhaltigkeitsberichterstattung, dem Nachhaltigkeitsrating und sozial verantwortlichen Investitionen (4), Ansätze weiterer Nichtregierungs-/Non-Profit-Organisationen (1) und Forschungsansätze (1). Lücken wurden identifiziert und Empfehlungen für die zukünftige Arbeit des ISC_3 abgeleitet.

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List of Abbreviations

ACC	American Chemistry Council
CEFIC	The European Chemical Industry Council
CFP	Carbon Footprint
CGCEN	Canadian Green Chemistry Engineering Network
CIAC	Chemistry Industry Association of Canada
CoHC	Chemical of high concern
DJSI	Dow Jones Sustainability Index
EHS	Environment, Health, Safety
ESG	Environmental, Social and Governance
G2C2	Global Green Chemistry Network
GC3	Green Chemistry Commerce Council, USA
GCN	Green Chemistry Network, United Kingdom
GNCN	Green Chemistry Network Center India
GRI	Global Reporting Initiative
GSCN	Green & Sustainable Chemistry Network Japan
ICCA	International Council of Chemical Associations
IGN	International Green Network
ISC_3	International Sustainable Chemistry Collaborative Centre
JCIA	Japan Chemical Industry Association
MRSL	Manufacturing Restricted Substances List
OECD	Organisation for Economic Co-operation and Development
RSL	Restricted Substances List
SASB	Sustainability Accounting Standards Board
SCP	Sustainable Chemistry Platform, hosted by OECD
SusChem	European Technology Platform for Sustainable Chemistry
TfS	Together for Sustainability
ZDHC	Zero Discharge of Hazardous Chemicals

Summary (English)

To allow the ISC$_3$ a quick start to its substantive work, the clients (UBA/BMUB) have commissioned the drafting of three studies. The objective of this study was to create a knowledge base by mapping the most relevant initiatives/approaches in the field of sustainable chemistry. For this purpose, the sectors and players shown in Table 1 were examined.

Table 1: Sectors and players analyzed

Sector	Subsector / Player
Green Chemistry	Green Chemistry Networks: ► Green Chemistry Network UK (GCN) ► Green Chemistry Network Center India (GCNC) ► Green Chemistry Commerce Council (GC3) ► Green Chemistry Network Brazil ► G2C2 network
	Green & Sustainable Chemistry Network Japan (GSCN)
	Other Green Chemistry players ► Green ChemisTree Foundation, India ► GreenCentre Canada
International organizations	United Nations Industrial Development Organization (UNIDO) ► Joint UNIDO UNEP Resource Efficient and Cleaner Production (RECP) Programme ► UNIDO´s Global Chemical Leasing Programme ► UNIDO's green industry initiatives: TEST (Transfer of Environmentally Sound Technologies) and MED TEST (TEST in the Mediterranean Region) ► UNIDO's Responsible Entrepreneurs Achievement Programme (REAP)
	OECD Sustainable Chemistry Platform (SCP)
(Chemical) Industry organizations and initiatives	Responsible Care® / International Council of Chemical Associations (ICCA)
	World Business Council on Sustainable Development (WBCSD)
	Together for Sustainability (TfS)
	Chemie[3]
	European Technology Platform for Sustainable Chemistry (SusChem)
Upstream / downstream value chain	Zero Discharge of Hazardous Chemicals (ZDHC)
	Clean Production Action / BizNGO
	Chemicals Policy Initiative at the Lowell Center for Sustainable Production
Companies	Europe: ► AkzoNobel, Netherlands ► Koninklijke DSM NV, Netherlands
	North America: ► Dow Chemical ► DuPont
	Asia: ► PTT Global Chemical PCL, Thailand ► Sinopec Corp.

Sector	Subsector / Player
Sustainability reporting, sustainability rating and socially responsible investment	Approaches in sustainability reporting: ► Global Reporting Initiative (GRI) ► Sustainability Accounting Standards Board (SASB)
	Approaches in sustainability rating and socially responsible investment: ► Dow Jones Sustainability Index (DJSI) family ► The MSCI ACWI Sustainable Impact Index
Further non-governmental/non-profit organizations	MVO Nederland, Netherlands
Research approaches	German Environment Agency (customer)

Source: Own compilation

The analysis showed a gap with regard to the definition and understanding of sustainable chemistry. In the past, green chemistry and sustainable chemistry were regarded as synonyms. Today a much more precise distinction is made between these approaches. With its definition of sustainable chemistry as a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services and also a process that stimulates innovation across all sectors, the OECD has set standards. UNIDO refers to the OECD definition, too.

Industry has no uniform definition of sustainable chemistry. Some refer more or less clearly to the triple bottom line approach, another cites the OECD definition of sustainable chemistry, proposes an LCA approach and stresses the need for acceptance by society. The evaluation of the approach of six chemical companies – all global players – shows that only one (Dow Chemical) has a clear understanding and definition of sustainable chemistry: "Green chemistry is a set of principles to design, but sustainable chemistry looks beyond only a science. It is a catalyst for change, an innovative approach to problem-solving and a long-term solution to global sustainability challenges. … Ultimately, chemistry and collaboration – and people – have the power to bend that straight line to a more positive point in the future, where nature and therefore human prosperity are in balance." Though it does not explicitly address social aspects in detail, this definition is close to the holistic approach of the OECD and the one that Blum et al. [2017] proposed with "the challenges in terms of social conditions, the inclusion of research, science and culture, and a successful long-term and sustainable way of management respecting the capacity-limits of our planet."

Indicators and metrics were also analysed. The development of indicators for measuring progress in the chemical industry is an ongoing process. Current reports on the sustainability progress of companies or sectors focus mainly on economic, ecological and social aspects. WBCSD offers some guiding documents for environmental aspects in the chemical industry, and is frontrunner with its guideline of 2016 on social life cycle metrics (its development was co-chaired by BASF, DSM and Solvay). ICCA periodically reviews its metrics to determine the need for any changes. SusChem will address sustainability more comprehensively across environmental, societal and economic issues along the whole value chain in conjunction with its stakeholders. Chemie^3 has published its catalogue of 40 indicators in late 2016. Since methodological questions and the application of the criteria are still open, the Chemie^3 approach cannot be evaluated. The TfS approach to sustainability or to sustainable supply chains is of interest, but indicators are not available for the public.

Of the six chemical companies selected for analysis, five have published a Sustainability / CSR Report (or integrated report) in accordance with GRI 4 guidelines. The indicator concept, criteria and metrics for reporting is therefore predefined. Companies are however allowed to use additional metrics to control their sustainability goals and four of them did so. These additional metrics include amongst

others solutions with downstream benefits, innovations for alleviating global challenges (like energy and climate change, water, food, housing and health), sum of people whose sustainable development challenges have been positively impacted, customer and supplier satisfaction, and position in Dow Jones Sustainability Indices.

The three UNIDO projects selected for evaluation show that their concept covers broad parts of the concept of sustainable chemistry defined by the German Environment Agency, like improvement of resource efficiency, environmentally friendly production and use of chemicals, the inclusion of the entire life cycle of a product.

The concepts of two Sustainability Indices were described, as positioning in the DJSI is an incentive for innovative chemical companies. The indicators of the MSCI ACWI Sustainable Impact Index have probably more potential for application to sustainable chemistry as they – consideration of ESG criteria and excellent operational performance provided – focus on the impact of chemical companies with regard to the SDGs.

Recommendations for the future work of ISC_3 included initiating a broader discussion on the indicators and metrics of the following aspects: Social conditions, research, science and culture, successful long-term and sustainable management approaches which respect our planet's capacity-limits, and observing further how first approaches developed by companies are applied in reality and what results are achieved.

Summary (German: Zusammenfassung)

Um dem ISC_3 einen schnellen Einstieg in die fachliche Arbeit zu ermöglichen, haben die Auftraggeber (UBA/BMUB) die Erstellung dreier Studien beauftragt. Das Ziel dieser Studie war die Schaffung einer Wissensbasis in Form einer Darstellung der wichtigsten Initiativen / Ansätze im Bereich der nachhaltigen Chemie. Zu diesem Zweck wurden die in Table 2 genannten Sektoren und Akteure analysiert.

Table 2: Analysierte Sektoren und Player

Sektor	Subsektor / Akteur
Green Chemistry	Green Chemistry Netzwerke: ► Green Chemistry Network UK (GCN) ► Green Chemistry Network Center India (GCNC) ► Green Chemistry Commerce Council (GC3) ► Green Chemistry Network Brazil ► G2C2 network Green & Sustainable Chemistry Network Japan (GSCN) Andere Green Chemistry Akteure ► Green ChemisTree Foundation, India ► GreenCentre Canada
Internationale Organisationen	United Nations Industrial Development Organization (UNIDO) ► Joint UNIDO UNEP Resource Efficient and Cleaner Production (RECP) Programme ► UNIDO´s Global Chemical Leasing Programme ► UNIDO's green industry initiatives: TEST (Transfer of Environmentally Sound Technologies) and MED TEST (TEST in the Mediterranean Region) ► UNIDO's Responsible Entrepreneurs Achievement Programme (REAP) OECD Sustainable Chemistry Platform (SCP)

Sektor	Subsektor / Akteur
Organisationen und Initiativen der (Chemie-) Industrie	Responsible Care® / International Council of Chemical Associations (ICCA) World Business Council on Sustainable Development (WBCSD) Together for Sustainability (TfS) Chemie[3] European Technology Platform for sustainable chemistry (SusChem)
Vor- bzw. nachgelagerte Wertschöpfungskette	Zero Discharge of Hazardous Chemicals (ZDHC) Clean Production Action / BizNGO Chemicals Policy Initiative at the Lowell Center for Sustainable Production
Chemieunternehmen	Europa: ► AkzoNobel, Netherlands ► Koninklijke DSM NV, Netherlands Nordamerika: ► Dow Chemical ► DuPont Asien: ► PTT Global Chemical PCL, Thailand ► Sinopec Corp.
Nachhaltigkeitsbericht-erstattung, Nachhaltigkeitsrating und sozial verantwortliches Investment	Nachhaltigkeitsberichterstattung: ► Global Reporting Initiative (GRI) ► Sustainability Accounting Standards Board (SASB) Nachhaltigkeitsrating und sozial verantwortliche Investitionen: ► Dow Jones Sustainability Index (DJSI) family ► The MSCI ACWI Sustainable Impact Index
Weitere Nichtregierungs-/Non-Profit-Organisationen	MVO Nederland, Niederlande
Forschungsansätze	Umweltbundesamt (Auftraggeber)

Quelle: Eigene Zusammenstellung

Bei der Analyse wurde eine Lücke hinsichtlich der Definition und des Verständnisses von nachhaltiger Chemie deutlich. In der Vergangenheit sind grüne Chemie und nachhaltige Chemie als häufig Synonyme betrachtet worden. Heute wird sehr viel genauer zwischen den unterschiedlichen Ansätzen differenziert. Die OECD hat mit ihrer Definition von nachhaltiger Chemie Standards gesetzt. Danach ist nachhaltige Chemie zum einen ein wissenschaftliches Konzept, das die Effizienz, mit der natürliche Ressourcen für die Erfüllung der menschlichen Bedürfnisse für chemische Produkte und Dienstleistungen genutzt werden, steigern will, auf der anderen Seite aber auch ein Prozess, der Innovation in allen Sektoren stimuliert. Die Chemieindustrie (bzw. ihre Verbände) hat (haben) keine einheitliche Definition von nachhaltiger Chemie. Einige verweisen mehr oder weniger deutlich auf den Drei-Säulen-Ansatz, ein anderer zitiert die OECD-Definition von nachhaltiger Chemie, schlägt einen LCA-Ansatz vor und betont zudem die Notwendigkeit der Akzeptanz durch die Gesellschaft. Auch die UNIDO bezieht sich hierauf.

Die Auswertung des Ansatzes von sechs Chemieunternehmen – alle global agierend – zeigt, dass nur eines (Dow Chemical) ein klares Verständnis und eine Definition von nachhaltigen Chemie hat: „Grüne Chemie ist ein Set von Prinzipien für das Design von Chemikalien, aber nachhaltige Chemie schaut

über den Tellerrand der Wissenschaft. Sie ist ein Katalysator für den Wandel, ein innovativer Lösungsansatz und eine langfristige Lösung für globale Herausforderungen in punkto Nachhaltigkeit." Diese Definition ist ziemlich nah am ganzheitlichen Ansatz der OECD sowie des UBA [Blum et al., 2017]: Bei beiden Ansätzen zählen auch die Bewältigung der Herausforderungen in Bezug auf soziale Bedingungen, die Einbeziehung von Forschung, Wissenschaft und Kultur sowie erfolgreiches, langfristiges und nachhaltiges Wirtschaften unter Berücksichtigung der Kapazitätsgrenzen unseres Planeten dazu.

Darüber hinaus wurden Indikatoren und Kennzahlen (metrics) analysiert. Die Entwicklung von Indikatoren für die Fortschrittsmessung ist ein fortlaufender Prozess. Aktuelle Berichte über den Nachhaltigkeitsfortschritt von Unternehmen oder Sektoren konzentrieren sich vor allem auf ökonomische, ökologische und soziale Aspekte. Der World Business Council on Sustainable Development (WBCSD) bietet mehrere umweltbezogene Leitfäden für die chemische Industrie und ist führend mit seiner Leitlinie von 2016 über soziale Lebenszyklus-Metriken (entwickelt unter dem Mitvorsitz von BASF, DSM und Solvay). Der Weltchemieverband ICCA überprüft regelmäßig seine Metriken auf Anpassungsbedarf. SusChem will in Verbindung mit seinen Stakeholdern Nachhaltigkeit umfassender über ökologische, gesellschaftliche und ökonomische Fragen entlang der gesamten Wertschöpfungskette thematisieren. Chemie^3 hat Ende 2016 ihren Katalog mit 40 Indikatoren veröffentlicht. Da methodische Fragen und die Anwendung der Kriterien noch offen sind, können diese derzeit nicht beurteilt werden. Der TfS-Ansatz für Nachhaltigkeit oder nachhaltige Lieferketten ist von Interesse, aber Indikatoren sind für die Öffentlichkeit nicht verfügbar.

Von den sechs für die Analyse ausgewählten Chemieunternehmen haben fünf einen Nachhaltigkeits-/CSR-Bericht (oder einen integrierten Bericht) gemäß GRI 4-Richtlinien veröffentlicht. Hier sind das Konzept der Indikatoren, die Kriterien und Kennzahlen für die Berichterstattung vorgegeben. Unternehmen dürfen aber auch durchaus zusätzlich eigene Kennzahlen verwenden; vier der analysierten Unternehmen haben davon Gebrauch gemacht. Zu diesen zusätzlichen Metriken gehören unter anderem Lösungen mit Vorteilen für die späteren Anwender, Innovationen zur Bewältigung globaler Herausforderungen (wie Energieversorgung und Klimawandel, Wasser, Nahrung, Wohnen und Gesundheit), Anzahl von Personen, bei denen die Herausforderungen einer nachhaltige Entwicklung im positiven Sinne beeinflusst wurden, Kunden- und Lieferantenzufriedenheit und Position des Unternehmens in Dow Jones Nachhaltigkeitsindizes.

Die drei für die Studie ausgewählten UNIDO-Projekte zeigen, dass ihre Konzepte umfassende Teile des vom deutschen Umweltbundesamt propagierten Konzepts der nachhaltigen Chemie abdecken, wie Verbesserung der Ressourceneffizienz, umweltfreundliche Herstellung und Verwendung von Chemikalien, Einbeziehung des gesamten Lebenszyklus eines Produktes.

Die Positionierung eines Unternehmens im Dow Jones Sustainability Index stellt für einige innovative Chemieunternehmen einen Anreiz dar. Daher wurde das Konzept dieses und eines weiteren Nachhaltigkeitsindexes analysiert. Demnach haben die Indikatoren des MSCI ACWI Sustainable Impact Index vermutlich mehr Potenzial für die Anwendung im Rahmen nachhaltiger Chemie, da diese – die Berücksichtigung von ESG-Kriterien (Environment Social Governance) und eine ausgezeichnete operative Performance vorausgesetzt – den Beitrag (impact) von Chemieunternehmen auf das Erreichen der Sustainable Development Goals der Vereinten Nationen in den Mittelpunkt stellen.

Die Empfehlungen für die zukünftige Arbeit des ISC$_3$ beinhalten u.a. eine umfassendere Diskussion über die Indikatoren und Kennzahlen der Aspekte soziale Bedingungen, Forschung, Wissenschaft und Kultur, erfolgreiche langfristige und nachhaltige Bewirtschaftung unter Berücksichtigung der Kapazitätsgrenzen unseres Planeten. Weiter sollte verfolgt werden, wie erste diesbezügliche Ansätze, die von Unternehmen entwickelt wurden, in der Realität angewandt und welche Ergebnisse erzielt wurden.

1 Introduction and objective

1.1 Objective: Description of the existing landscape

To allow the ISC_3 a quick start to its substantive work, the clients (UBA/BMUB) have commissioned the drafting of three studies. As the ISC_3 will not re-invent the wheel, this study intends to describe sustainability initiatives and approaches in the chemical sector already developed or under discussion – what is referred to as a "description of the existing landscape". The foreseen contents and structure of the study were discussed first with the clients and then with the members of the Advisory Council at the first AC meeting in December 2015. In view of limited resources and the objective of the ISC_3 as an institution with a broader overall perspective on the topic, it was agreed that the study can only provide a rough overview and a detailed analysis of selected examples. The objective of this study was therefore slightly revised and can be decribed as follows:

- Map the most relevant [certificates/]initiatives/approaches in the field of sustainable chemistry.
- Analyse their underlying goals, concepts, status of implementation and potentially available evaluation in sustainability programs with the application of appropriate criteria.
- Create a knowledge base for further discussion within the ISC_3.

1.2 Scope of the study

Together with the objective, the scope of the study was presented at the first AC meeting, specifying details and highlighting its limitations:

- Activities by international and national organizations with a governmental, industrial or non-governmental background will be selected.
- It is not intended to create a complete overview but to concentrate on the most important approaches and their contributions in the field.
- It is not intended to recommend a best approach but to create a basis for evaluation and assessment.

Several Advisory Council members are seeking the future direction of Sustainable Chemistry. For them, it is necessary to develop a vision by focussing more on the future and on forward-looking initiatives and not on what has been done so far.

A preliminary list of approaches to be analysed as well as potential criteria were presented at a workshop on June 23rd, 2016, and a summary of this discussion at the second AC meeting on June 24th, 2016, both in Frankfurt. The Advisory Council members recommended looking at certain elements in more detail. Some initiatives and criteria from downstream and upstream users should be added and the study should look at initiatives outside the developed countries.

The proposals made by the Advisory Council were implemented as follows:

- For inclusion of initiatives outside the developed countries, CSR reports by chemical companies in Africa, Asia, and Latin America and Caribbean were checked.
- For inclusion especially of NGO approaches, focus was laid on those NGOs with representatives in the AC.
- Selected initiatives and criteria from upstream/downstream users were included.

- For inclusion of stakeholder interests, CSR reports *in accordance with GRI G4* were checked, as they have to include feedback from the company's stakeholders on the issues they consider to be material[1] and which should be managed, measured and reported.
- The study includes a gap analysis.

The question whether sustainability certificates should be included ended in a controversial discussion. Certificates are normally designed for specific products or services – e.g. GOTS and other certificates or labels in the textile industry – and not for chemicals. The question is therefore whether or not such certificates are of value for the scope of the ISC_3. As a result of the discussion between the client and the contractors on 21st July, 2016, **certificates are excluded from the scope of this study**.

The final results of this study were then presented at the second workshop of the ISC_3 Advisory Council on December 1st, 2016, in Frankfurt. The final report includes the results of the discussion at the workshops and further written feedback from Advisory Council members.

2 Methods

The study was mainly performed by means of desktop research, above all by analysing the websites and e-documents of relevant actors (most of the websites cited in the footnotes were visited during August and November 2016 and have not been checked again).

2.1 Selection criteria

Basic selection criteria were:

- Website is still accessible
- Language: English (or German)
- Availability of information (no member login, no purchase of documents required)
- Actuality of website (no document mummies)
- Focus on chemicals (+ upstream/downstream use), e.g. green chemistry, sustainable chemistry, green biotechnology, OR on sustainable development (e.g. SDG(s))
- Substantial information on the website or in documents available for download

These basic selection criteria led to the exclusion of several approaches/initiatives, especially from Asia, Africa and Russia, because of the language criterion.

2.2 Characterization criteria

For characterization of the respective initiative or approach, a set of basic data was collected, including institution(s) behind initiative/approach, legal information, governance bodies and, if available, budget/funding, and adapted to the types of stakeholders in the different sectors. Table 3 shows the basic structure for characterization, which was adjusted depending on the focus (e.g. accounting, industrial sector approaches, company level etc.).

[1] Definition by Global Reporting Initiative: „Organizations are faced with a wide range of topics on which they could report. Relevant topics are those that may reasonably be considered important for reflecting the organization's economic, environmental and social impacts, or influencing the decisions of stakeholders, and, therefore, potentially merit inclusion in the report. **Materiality** is the threshold at which Aspects become sufficiently important that they should be reported. https://g4.globalreporting.org/how-you-should-report/reporting-principles/principles-for-defining-report-content/materiality/Pages/default.aspx

Table 3: Basic structure for characterization (adjustment according to assignment to a group)

Subject	Example (non-exhaustive)
Name/title	N.N.
URL	www.xxx.xx
Type of organisation	Industrial organization, industrial initiative, enterprise, governmental organization, academia
Coverage/region	Global, Europe, USA/Canada, Brazil, Africa/Nigeria, India, Japan …
Institution(s) behind initiative/approach	Named in full or described e.g. "22 leading brands committed to working together to drive industry-wide change"
Legal information	"AG" or "No legal entity"
Governance bodies	Board: Manages XY's overall strategy and activities. Management team: Responsible for implementation of the strategy.
President/CEO/Chairman	Name
Year of foundation	Year
Budget/funding	If available
Links/closeness to other stakeholders	If available
Target audience and sectoral/geographical scope	Government, academia, industry, professional societies, NGOs; international
Self-declared goal	Example: "… to further the cause of sustainability in the chemical industry by promoting sustainable business practices throughout …"
Definition of sustainable chemistry OR sustainability	Example: "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/SCP)
Concept of selected indicators	Single case report, e.g. decision hierarchy including function, costs, carbon footprint etc., if available
Launch year, change in concept (if any) since then	XXXX, change in XXXX, if available
Proposed instruments and measures for implementation	Single case report, if available
Status of implementation (e.g. description of best practice etc.)	Single case report, if available
Status and type of monitoring including e.g. time series of indicator measurements	Single case report, if available
Stakeholder engagement	Single case report, if available
Additional information	Single case report, if available

Source: Own compilation.

2.3 Evaluation criteria

The evaluation criteria were developed within an iterative process, based on the gradual improvement of the availability of information. The evaluation criteria include:

- Consistency of sustainable chemistry definition and its application in the approach
- Consistency of indicator concept and how it is monitored
- Role of SDGs in the concept
- Chance of implementation
- Overall impression, in case of sufficient information basis

3 Map of Sustainable Chemistry initiatives and approaches

The definition of sustainable chemistry is still under discussion. The OECD first introduced a holistic approach (for details see section 5.1): "Sustainable chemistry is a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services. … 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."

Blum et al. [2017] have further developed this approach: "Sustainable chemistry contributes to a positive, long-term development in society, environment and economy. With new approaches and technologies it develops value-creating products and services for the civil society needs. Sustainable chemistry increasingly uses substances, materials and processes with the least possible adverse effects. Moreover, substitutes, alternative processes and recycling concepts are used, and natural resources are conserved. Thus, damage and impairments to human beings, ecosystems and resources are avoided. Sustainable chemistry is based on a holistic approach, setting measurable objectives for a continuous process of change. Scientific research and education for sustainable development in schools and vocational training serve as an important basis for this development."

Holistic approach means: "On the one hand, the entire lifecycle of chemical products is considered. From molecular design, resource demand, synthesis, over distribution, usage as well as recycling, to end of life issues. This implicates that in addition to the chemical industry, downstream users of substances and materials, manufacturers of products and consumers are important players too, who have their roles in this holistic approach. On the other hand, this does not only involve effects on humans and the environment, but also challenges in terms of social conditions, the inclusion of research, science and culture, and a successful long-term and sustainable way of management respecting the capacity-limits of our planet." [Blum et al., 2017]

In another study performed within the project No. 3715 65 499 0, the authors point out [Fröhlich and Zeschmar-Lahl, 2017]: "Sustainable chemistry … aims to close the gap between ecologically viable solutions and economic success, taking into account economic and social dimensions as well as thinking in full life cycles. … sustainable chemistry is not a new sub-discipline of chemistry but guides trans- and interdisciplinary thinking to systematically find solutions for sustainable development. It requires and drives innovations, focusing in so doing on sustainable solutions (e.g. substitution, systemic thinking)."

Green Chemistry is mainly linked to the "twelve principles of green chemistry" developed by Anastas and Warner [1998], see sub-chapter 4.2.1. Green chemistry and sustainable chemistry are sometimes regarded as identical. For example, EPA says: "Green chemistry is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, use, and ultimate disposal. Green chemistry is also known as sustainable chemistry."[2]

Following Fröhlich et al. [2016], green chemistry is one of the basics of sustainable chemistry. Friege and Zeschmar-Lahl [2017] point out: "A "green" chemical – that is a chemical which was produced in accordance with the twelve principles of "green chemistry" and "green engineering" – will, however,

[2] https://www.epa.gov/greenchemistry/basics-green-chemistry#definition

only then make a contribution to sustainable development when it also contributes, in line with the sustainable chemistry principle, to the avoidance of hazardous waste, lower consumption above all of non-renewable raw materials, climate action and/or other important goals of the 2030 Agenda."

As a consequence, in this study green chemistry is included in the mapping of sustainable chemistry initiatives and approaches. The following table provides an overview of selected initiatives and approaches which focus on sustainable or green chemistry described in this study. Green Chemistry by EPA and the Presidential Green Chemistry Challenge Award (see section 4.1) are not analyzed in detail because they relate essentially to the twelve principles of Green Chemistry by Anastas and Warner [1998], while the study focuses on approaches to sustainable chemistry.

Table 4: Sustainable or green chemistry initiatives and approaches

Sector	Subsector	Example	Region
Green Chemistry	Green Chemistry Networks	Green Chemistry Network UK (GCN)	UK
		Green Chemistry Network Center India (GCNC)	India
		Green Chemistry Commerce Council (GC3)	USA
		Green Chemistry Network Brazil	Brazil
		G2C2 network	Global
		International Green Network (IGN)	International
	Green Chemistry Networks not described in detail	Canadian Green Chemistry Engineering Network (CGCEN)	Canada
		Green Chemistry Network Russia	Russia
	Green & Sustainable Chemistry Network Japan (GSCN)		Japan
	Other Green Chemistry players	Green ChemisTree Foundation, India	India
		GreenCentre Canada	Canada
International organizations	United Nations Industrial Development Organization (UNIDO)	Joint UNIDO UNEP Resource Efficient and Cleaner Production (RECP) Programme	Global
		UNIDO´s Global Chemical Leasing Programme	Global
		UNIDO's Responsible Entrepreneurs Achievement Programme (REAP)	Global
	OECD Sustainable Chemistry Platform (SCP)		International

Sector	Subsector	Example	Region
Chemical industry approaches	International Council of Chemical Associations (ICCA)	Responsible Care®	Global
	World Business Council on Sustainable Development (WBCSD)	Social Life Cycle Metrics for Chemical Products	Global
	Together for Sustainability (TfS)		Global
	European Technology Platform for Sustainable Chemistry (SusChem)		Europe
	Chemie[3]		Germany
Approaches from the upstream / downstream value chain	Zero Discharge of Hazardous Chemicals (ZDHC)		Global, with a focus on Asia
	Clean Production Action / BizNGO		USA
	Chemicals Policy Initiative at the Lowell Center for Sustainable Production		USA
	Further supply chain Initiatives	Pharmaceutical Supply Chain Initiative (PSCI)	USA
		Electronics Industry Citizenship Coalition (EICC)	Global
Approaches at company level	Europe	AkzoNobel, Netherlands	Global
		Koninklijke DSM NV, Netherlands	Global
	North America	Dow Chemical	Global
		DuPont	Global
	Asia	PTT Global Chemical PCL, Thailand	Global
		Sinopec Corp.	Global
Approaches in sustainability reporting, sustainability rating and socially responsible investment	Approaches in sustainability reporting	Global Reporting Initiative (GRI)	Global
		Sustainability Accounting Standards Board (SASB)	Global
	Approaches in sustainability rating and socially responsible investment	Dow Jones Sustainability Index (DJSI) family	Global
		The MSCI ACWI Sustainable Impact Index	Global
Approaches from further non-govern-mental/non-profit organizations	MVO Nederland, Netherlands		Netherlands and international
Research approaches	German Environment Agency (customer)		

Source: Own compilation

4 Green Chemistry

4.1 Background

"The 1990s was the decade during which Green Chemistry was introduced on a wide industrial scale, however, environmental statutes and regulations have already proliferated since the early 1960s. … In 1993, P. T. Anastas and C.A. Farris published the first book of the ACS Symposium series: Benign by Design, Alternative Synthetic Design for Pollution Prevention. This book provided an opportunity for several chemists, who were pioneers in the fields of benign by design chemistry, to present their research and it encouraged many scientists to become involved in environmentally responsible chemistry." [3]

Green Chemistry became an official focal area by the Environmental Protection Agency (EPA) and led to many activities in research, scientific conferences, and education. In 1996, the Presidential Green Chemistry Challenge Awards were granted for the first time. Since then, the EPA has received over 1,600 nominations and has presented awards to 109 winners.[4] Examples of Green Chemistry approaches based on summaries of US Green Chemistry Award winners' projects were used to create a European Green (and Sustainable) Chemistry Award in 1999[5].

"Another important step in the development of Green Chemistry was the foundation in 1997 of the Green Chemistry Institute in USA. After more than a year of planning by individuals from industry, government and academia, the Green Chemistry Institute (GCI) [6] was incorporated in 1997 as a not-profit corporation devoted to promoting and advancing Green Chemistry. In January 2001, GCI joined the American Chemical Society (ACS) in an increased effort to address global issues at the intersection of chemistry and the environment."[3]

In 1996, "IUPAC began its involvement in the Green Chemistry area by foundation of the Working Party on Synthetic Pathways and Processes in Green Chemistry under Commission III (Seoul, Korea 1996)." [3] Throughout the world, institutes and chairs for Green Chemistry (or with similar names) have been established and begun to network. For the purpose of this study, only a few of these networks are described.

4.2 Definitions

4.2.1 Twelve principles of Green Chemistry

The term "green chemistry" was first used in the 1990s and was defined at that time as "the design, development and implementation of chemical processes and products to reduce or eliminate substances hazardous to human health and the environment" [Anastas / Warner, 1998]. The "twelve principles of green chemistry" are [Anastas / Warner, 1998]:

[3] Prof. Fabio Aricò (University Ca'Foscari of Venice, Italy): Green Chemistry: 30 Years of History. EC2E2N NewsLetter – January 2014. http://www.ec2e2n.info/news/2014/1501_201401

[4] US EPA: Presidential Green Chemistry Challenge. Award Recipients 1996 – 2016. https://www.epa.gov/sites/production/files/2016-10/documents/award_recipients_1996_2016.pdf

[5] Allan Astrup Jensen: Establishment of a European Green and Sustainable Chemistry Award. Technical report N° 53. Final Report. European Environment Agency (EEA)Service Contract 3224/B1999.EEA.24803, 30 December 1999, Revised, 2000-06-28. http://www.eea.europa.eu/publications/FINAL_REPORT/download

[6] https://www.acs.org/content/acs/en/greenchemistry.html

1. Prevention
It is better to prevent waste than to treat or clean up waste after it has been created.

2. Atom Economy
Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

3. Less Hazardous Chemical Syntheses
Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

4. Designing Safer Chemicals
Chemical products should be designed to affect their desired function while minimizing their toxicity.

5. Safer Solvents and Auxiliaries
The use of auxiliary substances (such as solvents, separation agents, et cetera) should be made unnecessary whenever possible and innocuous when used.

6. Design for Energy Efficiency
Energy requirements of chemical processes should be recognized for their environmental and economical impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. Use of Renewable Feedstocks
A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

8. Reduce Derivatives
Unnecessary derivatization (use of blocking groups, protection/deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

9. Catalysis
Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

10. Design for Degradation
Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

11. Real-Time Analysis for Pollution Prevention
Analytical methodologies need to be further developed to allow for the real-time, in-process monitoring and control prior to the formation of hazardous substances.

12. Inherently Safer Chemistry for Accident Prevention
Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

Adhering to these principles is said to “prevent pollution and waste, lead to synthesis of chemicals in less hazardous and more efficient ways, promote the use of renewable feedstocks, and lead to the design of safer chemicals" [GC3, 2015].

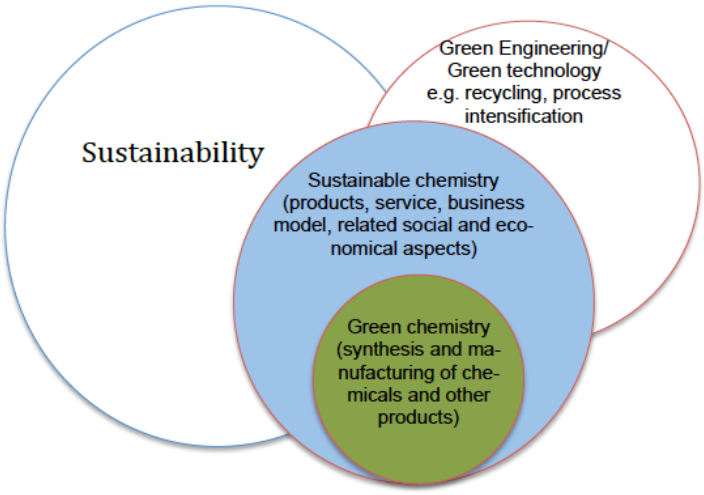
Following Kümmerer and Clark [2016], “the ultimate metric (for green chemistry) is life cycle assessment (LCA)”. They further point out: “In general, only rarely aspects that go beyond the chemicals themselves and technical issues are addressed by green chemistry whereas sustainable chemistry generally includes all aspects of a product related to sustainability e.g. social and economical aspects related to the use of resources the shareholders, the stakeholders and the consumers (Figure 1).”

As is pointed out by UNEP [2016], “upgrading industrial processes based on the principles of green chemistry can help to achieve SDG 9 on Industry, Innovation and Infrastructure.”

4.2.2 Twelve principles of Green Engineering

As pointed out by Kümmerer and Clark [2016], sustainable chemistry and green engineering (e.g. recycling, process intensification) overlap, too. Besides the 12 principles of green chemistry, the 12 principles for green engineering developed by Paul Anastas and Julie Zimmerman [2003] outline what would make a process or product greener. The principles of green engineering introduce several important requirements that we have to face within the sustainable chemistry framework, e.g. principles 7, 9, 11 and 12.

Figure 1: The relationship between sustainability, sustainable chemistry and green chemistry



Source: Kümmerer and Clark [2016]

The "twelve principles of green engineering" are [Anastas & Zimmerman, 2013]:

1. Inherent Rather Than Circumstantial
Designers need to strive to ensure that all material and energy inputs and outputs are as inherently non-hazardous as possible.

2. Prevention Instead of Treatment
It is better to prevent waste than to treat or clean up waste after it is formed.

3. Design for Separation
Separation and purification operations should be designed to minimize energy consumption and materials use.

4. Maximize Efficiency
Products, processes and systems should be designed to maximize mass, energy, space and time efficiency.

5. Output-Pulled Versus Input-Pushed
Products, processes and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.

6. Conserve Complexity
Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.

7. Durability Rather Than Immortality
Targeted durability, not immortality, should be a design goal.

8. Meet Need, Minimize Excess
Design for unnecessary capacity or capability (e.g. "one size fits all") solutions should be considered a design flaw.

9. Minimize Material Diversity
Material diversity in multi-component products should be minimized to promote disassembly and value retention.

10. Integrate Local Material and Energy Flows
Design of products, processes and systems must include integration and interconnectivity with available energy and material flows.

11. Design for Commercial "Afterlife"
Products, processes and systems should be designed for performance in a commercial "afterlife".

12. Renewable Rather Than Depleting
Material and energy inputs should be renewable rather than depleting.

4.3 Green Chemistry Networks

The order in which the networks are presented is chronological after the founding year (as far as known) and does not constitute a ranking.

4.3.1 Green Chemistry Network UK (GCN), 1998

"The main aim of the GCN is to promote awareness and facilitate education, training and practice of Green Chemistry in industry, commerce, academia and schools. This will be achieved by:

- Providing news and information about green chemistry via its website and newsletters
- Providing links to other organisations and government departments
- Helping to organise and promote relevant conferences/workshops and training courses
- Acting as a source of expertise in areas relating to green chemistry
- Providing educational material for universities & schools
- Running specific-themed projects targeting key areas and groups
- Establishing and supporting not-for-profit Research Centres focused on R&D in green chemical processes and regional networks for the promotion of green chemistry"

"Green chemistry includes such concepts as waste minimisation, solvent selection, atom utilisation, intensive processing and alternative synthetic routes from sustainable resources.

The challenge for chemists is to develop products, processes and services in a sustainable manner to improve quality of life, the natural environment and industry competitiveness.

Green Chemistry issues are here to stay. The most successful chemical companies of the future will be those who exploit its opportunities to their competitive advantage, and the most successful chemists of the future will be those who use Green Chemistry concepts in R & D, innovation and education."

Further details can be found in Table 5. Information was mainly sourced from the website of the University of York[7] and of the Royal Society of Chemistry[8].

[7] https://www.york.ac.uk/chemistry/research/green/networking/#tab-386704-4
[8] http://www.rsc.org/Membership/Networking/GCN/

Table 5: Green Chemistry Network (GCN), York: Short Characterization

Subject	Information
Name/title	Green Chemistry Network (GCN), York
URL	http://www.greenchemistrynetwork.org/
Type of organization	Network
Coverage/region	UK, Europe, global see below, G2C2, g2c2.www.greenchemistrynetwork.org
Institution(s) behind initiative/approach	Royal Society of Chemistry, UK
Legal information	Not-for-profit Company Limited by Guarantee (registered in England and Wales, No: 6879262)
Governance bodies	n.a.
President/CEO/Chairman	Non-Executive President: Prof. James Clark, University of York
Year of foundation	1998
Budget/funding	The network was initially launched in 1998 with funding from the Royal Society of Chemistry and is now funded on a project-by-project basis.
Links/closeness to other stakeholders	See below, G2C2
Target audience and sectoral/geographical scope	Chemists and chemical companies on a global scale
Self-declared goal	"Green Chemistry issues are here to stay. The most successful chemical companies of the future will be those who exploit its opportunities to their competitive advantage, and the most successful chemists of the future will be those who use Green Chemistry concepts in R & D, innovation and education. The Green Chemistry Network aims to help these chemical companies and chemists by sharing best practice, promoting green technology transfer and providing data to show that adoption of green practices can also provide cost benefits for industry. In addition, the GCN aims to make it possible for chemists of the future to grow up in an environment where green issues are not taught in isolation but form the underlying principles of all courses."
Definition of sustainable chemistry OR sustainability	None, only Green Chemistry in accordance with Anastas and Warner: "Green chemistry includes such concepts as waste minimisation, solvent selection, atom utilisation, intensive processing and alternative synthetic routes from sustainable resources."

Own compilation, using the following sources: University of York's and Royal Society of Chemistry's Websites
https://www.york.ac.uk/chemistry/research/green/networking/#tab-386704-4
http://www.rsc.org/Membership/Networking/GCN/

4.3.2 Green Chemistry Network Center India (GCNC), 1999

The Green Chemistry Network Centre (GCNC) was established in 1999 at the Department of Chemistry, University of Delhi, with the following aims and objectives:

- Build a network for exchange of expertise, discussion and knowledge between industrialists and academics and between chemists and engineers with interests and expertise relevant to Green Chemistry.
- Prepare and disseminate teaching materials on Green Chemistry for school, college and university levels, with the simultaneous design of laboratory experiments for these levels as well.
- Design training measures not just to expose chemists to the concepts, principles and methodologies of Green Chemistry but also to empower them to bring this new knowledge back to their institution or industries.
- Promote research by taking up Green Chemistry research projects from industry and government agencies.

Professor Anuradha Mishra, Gautam Buddha University, India, Green Chemistry Network Centre India, is a member of the G2C2 network. Coordinator of GCNC India is Professor R. K. Sharma, Department of Chemistry, University of Delhi. http://greenchem.du.ac.in/

Since this site does not offer any more substantial information, an overview table is omitted. Instead, the Green ChemisTree Foundation, India (page 40) is presented.

4.3.3 Green Chemistry Commerce Council (GC3), 2005

"The Green Chemistry & Commerce Council (GC3) is a cross sectoral, business-to-business network of companies and other organizations working collaboratively to accelerate green chemistry across sectors and supply chains."

"The GC3 is a project of the Lowell Center for Sustainable Production at the University of Massachusetts, Lowell. The Lowell Center for Sustainable Production (Lowell Center) is a research center based at the University of Massachusetts Lowell. … Lowell Center staff and consultants facilitate and manage all GC3 activities, in consultation with the GC3 Advisory Committee."

Further details can be found in Table 6. Information was mainly sourced from the GC3 website[9] and its guidelines and policies[10]. The Chemicals Policy Initiative at the Lowell Center for Sustainable Production is described on page 112.

Table 6: Green Chemistry & Commerce Council (GC3): Short Characterization

Subject	Information
Name/title	Green Chemistry & Commerce Council (GC3)
URL	http://www.greenchemistryandcommerce.org
Type of organization	Business-to-business network of companies and other organizations
Coverage/region	USA. Currently about 100 members[11], member companies span 13 major sectors and the entire value chain—from chemical manufacturing to retail.

[9] http://www.greenchemistryandcommerce.org/membership/current-members/

[10] http://www.greenchemistryandcommerce.org/documents/Membership-Guidelines-Policies.pdf

[11] http://www.greenchemistryandcommerce.org/membership/current-members/

Subject	Information
Institution(s) behind initiative/approach	Lowell Center for Sustainable Production at the University of Massachusetts, Lowell.
Legal information	Project of the Lowell Center for Sustainable Production
Governance bodies	GC3 director and co-director GC3 Advisory Committee[12]
President/CEO/Chairman	Joel Tickner, Director Monica Becker, Co-Director & Project Lead, Innovation
Year of foundation	2005
Budget/funding	Membership fees, sponsorships, conference fees, and philanthropic grants
Links/closeness to other stakeholders	E.g. Retailer portal, GC3 Innovators Roundtable
Target audience and sectoral/geographical scope	Companies and other organizations working collaboratively to accelerate green chemistry across sectors and supply chains; USA
Self-declared goal	Vision: Green chemistry, green engineering and design for the environment are standard practice throughout the economy, contributing to innovation, improved public health and protection of the environment. Strategic approach: ► Develop and promote tools, policies and business practices to drive green chemistry throughout supply chains ► Foster collaboration among businesses, government, non-governmental organizations, and academic researchers ► Identify and leverage enablers of green chemistry adoption
Definition of sustainable chemistry OR sustainability	None, only **Green Chemistry** in accordance with Anastas and Warner: "Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances throughout their lifecycles: design, manufacture, use, and end of life. Green chemistry is a growing field of practice that builds on conventional chemistry and engineering by applying **12 fundamental principles that guide the molecular design of sustainable chemical products and processes**.[1] Adhering to these principles prevents pollution and waste, leads to synthesis of chemicals in less hazardous and more efficient ways, promotes the use of renewable feedstocks, and leads to the design of safer chemicals." 1 U.S. EPA. 2015. Basics of Green Chemistry. Accessible at: http://www2.epa.gov/greenchemistry/basics-green-chemistry; Warner Babcock Institute for Green Chemistry. 2015. About Green Chemistry. Accessible at: http://www.warnerbabcock.com/green-chemistry/about-green-chemistry ; Center for Green Chemistry and Green Engineering at Yale. 2015. Green Chemistry and Green Engineering Defined. Accessible at: http://greenchemistry.yale.edu/green-chemistry-greenengineering-defined

Own compilation, using the following sources: GC3 website and GC guidelines and policies.
http://www.greenchemistryandcommerce.org/membership/current-members/
http://www.greenchemistryandcommerce.org/documents/Membership-Guidelines-Policies.pdf

[12] Members: http://www.greenchemistryandcommerce.org/about-gc3/advisory-committee

„The GC3 collaborated with the Michigan Green Chemistry Roundtable to create the Green Chemistry Checklist[13], a tool for firms to 'measure progress in creating a culture of innovation and in supporting the building blocks necessary to develop safer products.' The Checklist measures corporate progress in four specific areas (including key indicators and questions for each area), including: hiring, education, design and innovation, and support and communication (Fig. 1)."[14] See Annex II: The Green Chemistry Checklist.

4.3.4 Green Chemistry Network Brazil, 2007

The Brazilian Network on Green Chemistry was created in November 2007 at the first Brazilian Workshop on Green Chemistry in Fortaleza. "Its main objective is to be one of the central institutions to promote technological innovation for national companies, with the support of the scientific community and governmental agencies." [15]

"In a relatively short period of time the country has accumulated considerable experience in the large-scale production of biofuels[16], in particular those related to ethanol from sugar cane. A strategy to fully explore these comparative advantages is described in the text on: "Química Verde no Brasil (Green Chemistry in Brazil) 2010 – 2030" and is based on structuring a network of institutions, laboratories, pilot plants, and offices that are involved in research, development and innovation (R, D&I) on Green Chemistry. It includes the Escola Brasileira de Química Verde (Brazilian Green Chemistry School) that is creating a knowledge base and preparing teams of qualified researchers that are to conduct the research, development and innovation activities of the network."[17]

The coordinator of the Green Chemistry Network Brazil, Professor Peter Seidl, Brazilian Green Chemistry School, Rio de Janeiro, www.eq.ufrj.br/, is a member of the G2C2 network. Since the Brazilian Green Chemistry School's website does not offer any information in English, an overview table is omitted.

4.3.5 G2C2 Network, 2013

"The Global Green Chemistry Network was created following a gathering of leaders in Green Chemistry from India, Brazil, Mexico, South Africa, South Korea, the United States, Canada, and the United Kingdom in December 2013."[18]

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[13] Tickner and Becker (2016): „Michigan Green Chemistry Roundtable, Green Chemistry Checklist, http://www.greenchemistryandcommerce.org/assets/media/images/uml%20GC3%20checklist.pdf, 2014 (accessed 24.06.16) Developed by the Michigan Green Chemistry Roundtable (consisting of industry, government and non-profit collaborators, the Checklist is the first tool developed to evaluate a firm's efforts to institutionalize green chemistry in research and development, marketing, investment, and education."

[14] J.A. Tickner, M. Becker (2016): Current Opinion in Green and Sustainable Chemistry 1 (2016) 1-4 https://www.researchgate.net/profile/Monica_Becker3/publication/306528542_Mainstreaming_green_chemistry_The_need_for_metrics/links/586bb92a08ae6eb871bb6989/Mainstreaming-green-chemistry-The-need-for-metrics.pdf?origin=publication_detail&ev=pub_int_prw_xdl&msrp=PlmYziGuKFHjxYdbCPEKsibsOUY2gRmFFiB5ahsSS2hKYQ7ipNEI9ZTOkFpsbsgvIbGtG_aUuTnRrxAnjT0eV7sYfoLDMB2-fPG4bEbr12Y.ClCFVuRhpZcwfoMOHdCHdfHJnzMLpCe9Az9JGdjyd3Qp1u_Afi64k2AffaqyO_vtnu6FdUZmGo_55uqVkRA1Q.jg-XGM89fgEcz9jJ6hJCj83T8zNkENw7hwu7KQEPKeSl9HxDwoxkipIRP-qrlgrrMFuFcKJBFH-5z73TCJzLlQ

[15] Arlene G. Corrêa, Vânia G. Zuin, Vitor F. Ferreira, and Patricia G. Vazquez: Green chemistry in Brazil. Pure Appl. Chem., Vol. 85, No. 8, pp. 1643–1653, 2013. http://dx.doi.org/10.1351/PAC-CON-12-11-16 https://www.iupac.org/publications/pac/pdf/2013/pdf/8508x1643.pdf

[16] In case of land use change (for example, forest cleared) this is not sustainable.

[17] Peter Rudolf Seidl, Estevão Freire, Suzana Borschiver, Escola de Química da UFRJ, Rio de Janeiro, Brazil : EC2E2N NewsLetter, November 2011, 12 (10), Special C&S. Americas – Green Chemistry in Brazil. http://ectn-assoc.cpe.fr/news/letter/2011/10/1210_201111_Green_Chem_in_Brazil_151111.pdf

[18] https://www.york.ac.uk/chemistry/research/green/networking/#tab-386704-5

"The primary aim of G2C2 is to connect established and fledgling Green Chemistry Centres throughout the world, with an emphasis on:

- Networking and Conferences
- Education and Outreach
- Industry engagement
- Funding Opportunities – Fellowships, Travel and Research"[19]

Two meetings have been held up to now, the first was in Delhi in 2013: "By building an international network, the opportunity exists to overcome the limitations of each individual green chemistry centre, and to encourage individual chemists to bolster their research and education programs and broaden their impact. … The global challenge of sustainable living is real, and collaboration through an International Green Chemistry Network is an important piece of designing a better future." [20]

At the second meeting in Cape Town in 2014, it was pointed out: "What became clear from the discussion is that, as expected, centres in developed countries have greater support for collaboration with industry. It is, therefore, one of the greatest hopes of the G2C2 network that green chemistry initiatives in developing regions could tap into the wealth of expertise and experience that G2C2 has to offer when engaging with industrial partners." [21]

G2C2 is hosted by the Green Chemistry Network, York, see sub-chapter 4.3.1. Since the g2c2.greenchemistrynetwork.org site does not offer any more substantial information, an overview table is omitted.

4.3.6 Further Green Chemistry Networks

References to further Green Chemistry Networks were examined but did not lead to any exploitable results in the cases below.

4.3.6.1 International Green Network (IGN) (2005)

"In order to address the increasing need of Green Chemistry education, the Carnegie Group (the meeting of the G8 Ministers for Research is held twice a year) held in Victoria, Canada (June 2-3, 2005) and in New York (December 2-3, 2005), founded a research and training network on Green-Sustainable Chemistry: The International Green Network (IGN). The network was unanimously approved, following a proposal by the Italian Minister for Education, Research and University. The network was unanimously approved, following a proposal by the Italian Minister for Education, Research and University. INCA was selected as its hub, and will – along with the other research centres – dedicate a space within its institute to the IGN. The IGN aims to provide know-how, coordination and sponsorship for scientific collaborations, proper training for the new generation of chemists, and support for sustainable use of chemistry in developing nations."

The IGN website http://www.incaweb.org/research/green_chemistry/index.php was last updated in 2010. The latest publication on http://www.incaweb.org/publications/gcseries.php is from 2005.

4.3.6.2 Canadian Green Chemistry Engineering Network (CGCEN)

The website of the Green Chemistry Network Canada (www.greenchemistry.ca) is no longer available. The CGCEN is therefore presented here.

[19] http://g2c2.greenchemistrynetwork.org/sign-up/

[20] G2C2: First meeting, 2013: http://g2c2.greenchemistrynetwork.org/wp-content/uploads/2014/11/G2C2-first-meeting-Delhi.pdf

[21] G2C2: Second meeting, 2014: http://g2c2.greenchemistrynetwork.org/wp-content/uploads/2014/11/G2C2-second-meeting-Cape-Town.pdf

"The Canadian Green Chemistry Engineering Network (CGCEN) is a network of the Chemical Institute of Canada (CIC). It is a multidisciplinary network that brings together leading researchers and practitioners in chemistry, biochemistry and chemical engineering with policy makers, industrial partners and professional organizations in the areas of alternate and conventional energy, chemical and biochemical manufacturing processes, new materials, and pharmaceuticals. CGCEN considers the whole innovation cycle from research to commercial implementation. It promotes the 12 Principles of Green Chemistry and the 12 Principles of Green Engineering by green chemistry and engineering symposia at the CIC's conferences, workshops, and seminars."[22]

Another potential successor of the Green Chemistry Network Canada is the GreenCentre Canada (page 41).

4.3.6.3 Green Chemistry Network Russia

The website of the Green Chemistry Network Russia (http://www.greenchemistry.ru) is only available in Russian.

A survey on 104 Russian companies representing almost the entire chemical complex and related industries in 2013 showed "that, although the enterprises of the Russian chemical industry are not familiar with the concept of 'green chemistry', they have started using it in practice. … In the first place, the principles related to production safety and efficiency are in demand. The highest level is characteristic of the following green principles: Inherently Safer Chemistry for Accident Prevention (44%), Atom Economy (41%), and Prevention (40%). In the opinion of business, principles associated with environmental friendliness are promising. The following principles are considered most appropriate for introduction at Russian enterprises: Design for Degradation (55%), Design for Energy Efficiency (50%), Real-Time Analysis for Pollution Prevention, and Less Hazardous Chemical Synthesis and the Use of Renewable Feedstocks (49%).[23]

4.4 Green & Sustainable Chemistry Network Japan (GSCN), 2000

"The Green Chemistry (GC) Initiative, a task force consisting of representatives from Japanese chemical organizations, was formed in September 1998. It worked actively to implement practical methods of effectively pursuing the above goals. To this end, a workshop was held in Tokyo in November 1999. The participants agreed to establish a new organization, Green & Sustainable Chemistry Network (GSCN) and the official name, concept, structure and framework of the activities by this new organization. The Green & Sustainable Chemistry Network (GSCN) was officially launched in March 2000." [24]

GSCN does not distinguish between Green Chemistry and Sustainable Chemistry. On the contrary, both are equated and defined as "chemical sciences and technologies which are benign to both human health and the environment, and support the development of a sustainable society."[24]

Further details can be found in Table 7. Information was mainly sourced from the GSCNwebsite[24] and the full text of Initiative GSC-21[25]. The GSCN newsletter is said to be issued quarterly, but the latest edition (English) was published in January 2015.[26]

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[22] http://www.cheminst.ca/connect/forums/cgcen

[23] N. P. Tarasova, A. S. Makarova, S. Yu. Vavilov, S. N. Varlamova, and M. Yu. Shchukina: Green Chemistry and Russian Industry. Herald of the Russian Academy of Sciences, 2013, Vol. 83, No. 6, pp. 499–505. DOI: 10.1134/S1019331613060117 https://www.researchgate.net/profile/Anna_Makarova4/publication/263268686_Green_chemistry_and_Russian_industry/links/569e436508ae82c7c2961b17/Green-chemistry-and-Russian-industry.pdf?origin=publication_detail

[24] http://www.jaci.or.jp/english/gscn/page_01.html

[25] GSCN: Initiative GSC-21 – Challenge of Chemical Technology – March 13-15, 2003 http://www.jaci.or.jp/english/gscn/pdf/initiativegsc-21.pdf

[26] http://www.jaci.or.jp/english/gscn/pdf/news_letter/no54.pdf

Table 7: Green & Sustainable Chemistry Network, Japan: Short Characterization

Subject	Information
Name/Title	Green & Sustainable Chemistry Network (GSCN), Japan
URL	http://www.jaci.or.jp/english/gscn/
Type of organization	Network, about 30 members http://www.jaci.or.jp/english/gscn/page_02.html
Coverage/region	Japan
Institution(s) behind initiative/approach	► The Society of Chemical Engineers, Japan ► The Society of Polymer Science, Japan ► The Chemical Society of Japan ► National Institute of Advanced Industrial Science and Technology ► Japan Chemical Industry Association ► The Association for the Progress of New Chemistry ► Japan Association for International Chemical Information ► Japan Bio-Industry Association ► Chemical Evaluation and Research Institute, Japan ► Japan Chemical Innovation Institute
Legal information	n.a.
Governance bodies	Board of Councellors Board of Directors GSCN Council GSCN Management Committee[27]
President/CEO/Chairman	n.a.
Year of foundation	2000
Budget/funding	n.a.
Links/closeness to other stakeholders	n.a.
Target audience and sectoral/geographical scope	Chemical industry, but also technologists, sociologists, economists, persons of NGO/NPO and consumers[25]
Self-declared goal	The main mission of the GSCN is to promote R&D on Green & Sustainable Chemistry as a center of network, through such activities as promotion of collaboration including international activities, information exchange, communication, education and relevant proposals to funding agencies.
Definition of sustainable chemistry OR sustainability	Green and Sustainable Chemistry is defined as chemical sciences and technologies which are benign to both human health and the environment, and support the development of a sustainable society.

Own compilation, using the following sources: GSCN website (English) and GSCN: Initiative GSC-21 – Challenge of Chemical Technology – March 13-15, 2003 http://www.jaci.or.jp/english/gscn/page_01.html and http://www.jaci.or.jp/english/gscn/pdf/initiativegsc-21.pdf

The examples given for green and sustainable chemistry have been examined for interfaces with the twelve principles of green chemistry (see 4.2.1, page 28).

[27] http://www.jaci.or.jp/english/gscn/img/sosiki.jpg

Table 8: GSCN, Japan: Examples of Green & Sustainable Chemistry and corresponding Green Chemistry principle

Target	Achieved through …	GC Principle
Minimization of resource consumption and maximization of the efficiency of reaction processes for production with reduced environmental impact.	(1) Chemical technologies that lead to reduction in by-product formation and avoid the use of hazardous substances	2, 3, 8
	(2) Separation, purification, and recycling technologies that reduce the generation and emission of greenhouse gases like CO_2 or toxic/hazardous substances, thus lowering environmental impact	4
	(3) Chemical technologies and products that reduce the generation and emission to the environment of greenhouse gases like CO_2 or toxic/hazardous substances.	4
	(4) Catalysts and reaction processes that realize the saving of energy and resources and improvement in product yields	5, 9
Risk reduction of chemical substances beneficial to safe and secure living environment	(5) Chemical technologies, products, and systems that reduce waste generation;	1, 2
	(6) Chemical technologies, products, and systems that inhibit the generation and emission of hazardous substances and pollutants	3
Challenges to solve energy, resource, food, and water issues	(7) Chemical technologies, products, and systems to utilize low-grade heat sources, non-conventional resources, and other similar alternatives	6
	(8) Chemical technologies, products, and systems whereby un-utilized energy and resources can be converted into available energy, transported, and stored	1, 2
	(9) Chemical technologies, products, and systems which decrease the dependence on exhaustible resources such as fossil fuels and scarce minerals and promote the shift to renewable energy and resources, including their storage;	7
	(10) Chemical technologies, products, and systems that contribute to the Three R's: Reduce, Reuse and Recycle;	1
	(11) Chemical technologies, products, and systems that promote the efficiency of production and supply of food, and utilization of water resources.	NEW
Pioneering challenges to long-term issues aiming to realize a safe, secure, and sustainable society with enhanced quality of life	(12) Chemical technologies, new products, and new operational systems that contribute to the introduction of new social systems, for instance based on ICT, and aimed at solving social issues such as energy and resource consumption, food and water security, disaster prevention and infrastructure improvements, transportation and logistics, medical and health care, education and welfare, and other mega-trends of society.	NEW
	(13) Chemical technologies, new products, and new operational systems that contribute to the improvement of social and individual comfort whilst reducing and preferably inhibiting environmental impact	NEW

Target	Achieved through …	GC Principle
Systemization, dissemination, enlightenment, and education of GSC including its metrics to be established	(14) Systemization of GSC practices and concepts (15) Dissemination, enlightenment, and education of GSC practices and concepts. (16) Establishment and dissemination of GSC metrics	NEW NEW NEW

Source: Own compilation

As Table 8 shows, there are many overlaps (partial or complete), but some of the measures described are not covered by the 12 principles, e.g. the systemization, dissemination, enlightenment, and education of GSC including its metrics.

Measures 11 to 13 refer to society's development (impact criteria) and are therefore more likely criteria for sustainable chemistry:

(11) Chemical technologies, products, and systems that promote **the efficiency of production and supply of food, and utilization of water resources**.

(12) Chemical technologies, new products, and new operational systems that contribute to **the introduction of new social systems**, for instance based on ICT, and aimed at **solving social issues** such as energy and resource consumption, food and water security, disaster prevention and infrastructure improvements, transportation and logistics, medical and health care, education and welfare, **and other mega-trends of society**.

(13) Chemical technologies, new products, and new operational systems that contribute to the **improvement of social and individual comfort** whilst reducing and preferably inhibiting environmental impact

4.5 Other Green Chemistry players

The following players were added because information about the respective corresponding national Green Chemistry Network was very limited (India) or the network's website was no longer available.

4.5.1 Green ChemisTree Foundation, India

The Green ChemisTree Foundation is an initiative started by Newreka Green Synth Technologies Pvt. Ltd., Mumbai.

"With our global vision of creating an ecology that forwards the applications of green chemistry and green engineering technologies world-wide, we at Newreka have taken up various initiatives under the banner of our non-profit organization – Green ChemisTree Foundation. We aim to sensitize Chemical Industry stakeholders from various walks of life, both in public and private domains by participating in and organizing various events."[28]

"Green ChemisTree Foundation is a registered not-for-profit organization, with the vision to bring forth technical know-how regarding green chemistry and engineering applications amongst the chemical community including Industry, Academia, Research Institutes, Govt. bodies, and Students.

The Green ChemisTree Foundation has emerged as a focused platform to engage the Industry and Non-Industry groups in exploring the world of Green Chemistry and Engineering practices, as a possi-

[28] http://www.newreka.co.in/corporate-social-responsibility/newreka-initiatives.html

ble way of doing chemistry and impacting the collective 'green' consciousness across the value chain of the Chemical Industry:

- by creating a new DNA of thoughts – for preventing, providing, and partnering
- by bringing together and bridging various Chemical communities (industry, academia, researchlaboratories & govt. bodies)
- by bringing into focus the industrialization and implementation of green chemistry and engineering"[29]

The Green ChemisTree Foundation has launched the Industrial Green Chemistry World (IGCW)[30]. The IGCW Conferences (the fourth took place in 2015[31], the fifth is scheduled for 2017) serve as a platform for key Green Chemistry stakeholders in India to share experience and best practices. "IGCW-2017 is an expression to augment IGCW's overall scope and outcome with the core objective to drive industry implementation of green chemistry and engineering based technologies to sustainably address priority and pressing environmental challenges of our Chemical Industry."[32]

For exchange and networking, an **IGCW network** has been established, comprising "over 15,000 green chemistry enthusiasts, both from Industry and Academia, from across the globe active on IGCW social media. The e-IGCW network utilizes the IGCW social media platform to get connected to seekers or providers of green chemistry based solutions, technologies and/or practices. It is an ongoing virtual platform for the Chemical Industry to engage in and explore various green chemistry focused resources, events, initiatives and opportunities." [33]

Executive Director of the Green ChemisTree Foundation is Krishna Dave, Public Relations Officer at Newreka Green Synth Technologies Pvt. Ltd., Mumbai.

4.5.2 GreenCentre Canada

GreenCentre Canada was formed in 2009 and funded by the Government of Ontario, the Government of Canada, and various industrial partners. GreenCentre is a member of the Centres of Excellence for Commercialization and Research (CECR) and has its headquarters at the Innovation Park of Queen's University in Kingston, Ontario, Canada. "GreenCentre's mission is to work with industry and academia to advance novel green chemistry research and technologies that improve both the economy and the environment. … It promotes the 12 Principles of Green Chemistry and the 12 Principles of Green Engineering." [34]

GreenCentre Canada's former Executive Director, Dr. Rui Resendes (now President at the Canadian Society for Chemistry), and Dr. Philip Jessop, the Canada Research Chair of Green Chemistry and a professor in the Departments of Chemistry and Environmental Studies at Queen's University, are a members of the G2C2 network.

4.6 Interim conclusion on Green Chemistry

Green Chemistry has grown up. Meanwhile, throughout the world, institutes and chairs for Green Chemistry (or named similar) have been established and begun to network. But – as far as this could be ascertained in the context of this study – there is no structure for a "network of the networks", nei-

[29] http://www.greenchemistree.co.in/about.html
[30] http://www.industrialgreenchem.com
[31] http://www.greenchemistree.co.in/pdf-docs/IGCW%202015/IGCW-2015%20Brief%20Report.pdf
[32] http://www.greenchemistree.co.in/igcw%20copy.html
[33] http://www.greenchemistree.co.in/Activities.html
[34] https://www.greencentrecanada.com/

ther for the green nor for the green and sustainable ones. G2C2, hosted by the Green Chemistry Network, York, is a current approach to establish a new network, but the focus lies clearly on green, not on sustainable chemistry. The only network that addresses (green and) sustainable chemistry is the one in Japan, but the definitions are not really clear. Finally, there is a gap in the networking of people, universities and companies working in sustainable chemistry.

5 International Organizations

5.1 United Nations Industrial Development Organization (UNIDO)

5.1.1 Characterization

„UNIDO is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability."[35] "The mandate of the Organization, as described in the Lima Declaration adopted at the fifteenth session of the UNIDO General Conference in 2013, is to promote and accelerate **inclusive and sustainable industrial development (ISID)** to achieve shared prosperity and environmental sustainability around the world. The concept of ISID is included in the Sustainable Development Goals, namely **Goal 9**: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation."[36]

„The **concept of green industry**, with the focus on the elimination or significant reduction of the dependence on hydrocarbon fuels, toxins, and equipment and processes that generate greenhouse gases, is one of the crucial responses to the prerequisite of sustainable development that UNIDO has developed, and continues to promote in its activities at all levels. Relying on its technical expertise, UNIDO's activities in this area aim to help countries around the world to strive for a viable balance between the pursuit of prosperity and sound environmental stewardship."[37]

"In an effort to spread the word about Green Chemistry, the United Nations Industrial Development Organization (UNIDO) and partners have launched a global multi-stakeholder initiative to increase global awareness and to deploy Green Chemistry approaches and technologies. … The UNIDO Green Chemistry initiative brings together a large research consortium led by the Centre for Green Chemistry and Green Engineering at Yale University, the German Federal Environmental Foundation, and Braskem, the largest thermoplastic resins producer in the Americas, as well as several National Cleaner Production Centres (NCPCs) from Latin America, Africa, Asia and Eastern Europe. … This project is the first GEF-funded global public-private partnership to bridge the gap between science-based innovation and real-world application of Green Chemistry in developing countries and economies in transition. UNIDO's major initiative on Green Chemistry aims to address the challenges posed by hazardous chemicals through holistic, wide-ranging actions and the preventive design and management of chemicals and waste." [38]

„The Organization's programmatic focus is structured in three thematic priorities, each of which represents different aspects of ISID:

- Creating shared prosperity
- Advancing economic competitiveness
- Safeguarding the environment

[35] http://www.unido.org/who-we-are/unido-in-brief.html

[36] http://www.unido.org/who-we-are/unido-and-the-sdgs.html

[37] UNIDO: The 2030 Agenda for Sustainable Development: Achieving the industry-related goals and targets. http://www.unido.org/fileadmin/user_media_upgrade/Who_we_are/Mission/ISID_SDG_brochure_final.pdf

[38] http://www.unido.org/news/press/unido-and-partners-l.html

Each of these programmatic fields of activity contains a number of individual programmes, which are implemented in a holistic manner to achieve effective outcomes and impacts through UNIDO's four enabling functions: (i) technical cooperation; (ii) analytical and research functions and policy advisory services; (iii) normative functions and standards and quality-related activities; and (iv) convening and partnerships for knowledge transfer, networking and industrial cooperation."[35]

„UNIDO has two policymaking organs: the General Conference and the Industrial Development Board. The Programme and Budget Committee is a subsidiary organ of the Industrial Development Board.

- **General Conference** (GC): The General Conference determines the guiding principles and policies of the Organization and approves the budget and work programme. Every four years, the Conference appoints the Director General. It also elects the members of the Industrial Development Board and of the Programme and Budget Committee. The Conference meets every two years.
- **Industrial Development Board** (IDB): The Board has 53 members, elected for a four-year term on a rotational basis. It reviews the implementation of the work programme, the regular and operational budgets and makes recommendations to the Conference on policy matters, including the appointment of the Director General. The Board meets once a year.
- **Programme and Budget Committee** (PBC): The Committee consists of 27 members, elected for a two-year term. It is a subsidiary organ of the Board which provides assistance in the preparation and examination of the work programme, the budget and other financial matters. The Committee meets once a year."[39]

UNIDO has currently 168 Member States. Further details can be found in Table 9. Information was mainly sourced from UNIDO's website[40].

Table 9: United Nations Industrial Development Organization (UNIDO): Short Characterization

Subject	Information
Name	United Nations Industrial Development Organization (UNIDO)
(Main) URL	http://www.unido.org/
Type of organisation	International organisation
Coverage/region	Global; UNIDO currently has 168 Member States[41]
Institution(s) behind initiative/approach	United Nations
Legal information	Specialized agency of the United Nations (since 1979)
Governance bodies	General Conference (GC) Industrial Development Board (IDB) Programme and Budget Committee (PBC)
President/CEO/Chairman	LI Yong (People's Republic of China), Director General
Year of foundation	1966 (as an autonomous body within the United Nations)

[39] http://www.unido.org/who-we-are/structure.html
[40] http://www.unido.org/
[41] http://www.unido.org/member_states.html

Subject	Information
Budget/funding	Compulsory contributions from the Member States on the basis of the UN contribution table, extraordinary revenues for technical cooperation, funds
Links/closeness to other stakeholders	"UNIDO collaborates with UN System agencies, such as the United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO), International Labour Organization (ILO), United Nations Conference on Trade and Development (UNCTAD), World Food Programme (WFP), United Nations Environment Programme (UNEP), International Trade Center (ITC) and the United Nations High Commissioner for Refugees (UNHCR)."[42]
Target audience and sectoral/geographical scope	Member States, the private sector, civil society and other partners; international
Self-declared goal	Promotion of industrial development for poverty reduction, inclusive globalization and environmental sustainability
Definition of sustainable chemistry resp. sustainability	"Sustainable Chemistry contributes to the improvement of resource efficiency and risk minimisation in the chemical industry and aims at an environmentally friendly production and use of chemicals including, for example, the prevention of pollution and waste, the inclusion of the entire life cycle of a product, or the enhancement of a product's recyclability and durability. This "encompasses the design, manufacture and use of efficient, effective, safe and more environmentally sound chemical products and processes" (source: http://www.oecd.org/env_sustainablechemistry_platform/). Thus, sustainable chemistry is essential for long-term sustainable development. It respects the need to improve the quality of human life within the carrying capacity of the world."[43] Sustainability: Triple bottom line approach
Concept of selected indicators	See below: UNIDO's Projects on Sustainable and Green Chemistry and on CSR
Stakeholder dialogue	"UNIDO recognizes that stakeholder engagement and building solid partnerships are necessary to achieve development results. UNIDO's convening role brings Member States, the private sector, civil society and other partners together in major outcome-oriented events that serve to exchange and disseminate knowledge and information, facilitate partnerships, and forge common positions and plans of action for inclusive and sustainable industrial development."[44]
Additional information	In 2016, UNIDO started its project on "Guidance development and case study documentation of green chemistry and technologies" funded by the GEF. Full information here: https://www.thegef.org/project/guidance-development-and-case-study-documentation-green-chemistry-and-technologies

Own compilation, mainly sourced from UNIDO's website: http://www.unido.org

[42] UNIDO IN THE UNITED NATIONS SYSTEM-WIDE COHERENCE AND DELIVERING AS ONE. A multi-pronged approach to achieving common goals. 2015 http://www.unido.org/fileadmin/media/images/worldwide/UNIDO_in_UNSWC__DaO.pdf

[43] http://chemicalleasing-toolkit.org/node/61

[44] https://50.unido.org/impact/index.html#partnership

5.1.2 Joint UNIDO UNEP Resource Efficient and Cleaner Production (RECP) Programme

5.1.2.1 Characterization

"UNIDO helps with the adaptation and adoption of Resource Efficient and Cleaner Production (RECP) methods, technologies and systems by enterprises and other organizations in developing and transition countries. These contribute to:

- Efficient use of natural resources, including materials, water and energy
- Minimization of wastes and emissions, including those discharged to water, air or on land
- Reduction of risks to humans and environment from use of chemicals and disposal of chemicals used in industry.

... RECPnet is comprised of National Cleaner Production Centres and Programmes (NCPCs/NCPPs) and other providers of RECP services."[45]

"The Network for Resource Efficient and Cleaner Production (RE CPnet) brings together over 70 providers of RE CP services on a global level in order to catalyze the effective and widespread application of RE CP in developing and transition countries. It does so by providing specialized, quality-assured, technical and advisory services and by facilitating and synergizing its members' capacities." [46]

"All RECPnet Members gain full access to technical and sector-specific information on RECP concepts, methods, policies, best practices and technologies."[47] For non-members, at RECP's homepage (http://www.recpnet.org) only selected information is available.

5.1.2.2 Criteria

One of the materials publicly available at RECP's homepage is the Green Company Rating System.

"The Green Company Rating System advocates a performance based approach. It is unique as it is highly performance oriented and significant weightage is provided for the performance / results achieved (70%). The company has to perform and achieve superior performance in most of the Green parameters to reach highest rating level. The rating system evaluates green features for companies against the following performance parameters." [48]

There are different criteria and weightages for the manufacturing sector (automobile & engineering, cement, FMCG (Fast-moving consumer goods), fertilizers, foundry, glass, iron/steel & non ferrous metals, pharmaceutical & chemicals, pulp & paper, refineries & petrochemicals, tyre & textile) and the service sector (IT & IT services, logistics, corporate houses, airports, hospitals, hotels), see Table 10.

"Weightages (points) are assigned to varying degrees of goals that are set for each of these parameters. For example, the points are awarded for reducing energy consumption. But points awarded will be higher for a business that demonstrates a higher degree of reduction in energy consumption compared to another business that demonstrates a lower degree of reduction in energy consumption. The companies at various levels of efficiency (for example, top 5 energy efficient plants in the world / national level) are also suitably recognized in this rating system."[48]

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[45] https://www.unido.org/cp/

[46] UNIDO: Global Promotion and Implementation of Chemical Leasing Business Models in Industry, 10 Years Report and Strategy Outlook. Vienna, 2016 http://www.chemicalleasing.org/sites/default/files/20160310_10%20Years%20Chemical%20Leasing%20Report%20and%20Strategy%20Outlook_FV.pdf

[47] http://www.recpnet.org/join-recpnet/

[48] UNIDO: GreenCo Rating System: Pilot Application of Innovative Assessment Methods for Resource Efficient and Cleaner Production (RECP) in Selected Manufacturing Sectors in India. Copyright© 2015 by the Confederation of Indian Industry. http://asiapacific.recpnet.org/uploads/resource/0b229425a6bef22e5b92492e5be7227a.pdf

Amongst the 17 case studies, only one is from the chemical sector (Hindustan Petroleum Corporation Limited (HPCL): Silvassa Lube Oil Blending Plant). Here, the application of the criteria no. 1, 3, 4, 5, 6 and 8 is described, but the achieved single scores or the final score are not published.

Table 10: UNIDO/CII: Criteria and weightages for the Green Company Rating System in India

No.	Parameters	Manufacturing Sector	Service Sector*
1	Energy Efficiency	150	150
2	Water Conservation	100	100
3	Renewable Energy	100	100
4	GHG Emission Reduction	100	100
5	Waste Management	100	100
6	Material Conservation, Recycling & Recyclables	100	75
7	Green Supply Chain	100	75
8	Product Stewardship	75	Not Applicable
9	Life Cycle Assessment	75	Not Applicable
10	Others (Ventilation, Site Location & Innovation)	100	100
	Total	**1000**	**800**

* For service sector, GreenCo Rating Level will be arrived after extrapolating the total score to 1000 points.
Source: UNIDO: Global Promotion and Implementation of Chemical Leasing Business Models in Industry, 10 Years Report and Strategy Outlook. Vienna, 2016
http://www.chemicalleasing.org/sites/default/files/20160310_10%20Years%20Chemical%20Leasing%20Report%20and%20Strategy%20Outlook_FV.pdf

5.1.2.3 Evaluation

UNIDO's partner, the Confederation of Indian Industry (CII) is very satiesfied with the success of the System: "The GreenCo Rating System has been receiving an excellent response from the Indian industry. With the growth curve showing a gradual rise, companies have realised different types of benefits. GreenCo has helped companies strength their existing systems and improve their overall environmental performance. … 63 GreenCo rated companies, 180 companies working on the rating system and Rs 192 Million recurring savings reported by 12 GreenCo rated companies – GreenCo in several industries has demonstrated Green makes good Business Sense."[48]

Due to the limited nature of the available data, the assessment shown in Table 11 is to be regarded as conditional.

Table 11: Evaluation of UNIDO's/CII's Green Company Rating System in India

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	Consistent referring to the triple bottom line approach; covers broad parts of the concept of sustainable chemistry defined by the German Environment Agency (Table 9), like improvement of resource efficiency, environmentally friendly production and use of chemicals, the inclusion of the entire life cycle of a product.
Consistency of indicator concept and how it is monitored	Indicator concept is consistent, following Blum et al.[52]; only few data gaps. Monitoring is part of the contract (see check list, Table 12). In practice, it depends on the details of the CL contract.
Role of SDGs in the concept	"Strong linkage between the Programme, the newly adopted UN Sustainability Agenda 2030 and the corresponding Sustainable Development Goals, in particular, SDG 9" [46]
Probability of implementation	Implemented in many countries
Overall impression	Valuable tool for implementing sustainable chemistry

Source: Own compilation

5.1.3 UNIDO´s Global Chemical Leasing Programme

5.1.3.1 Characterization

"UNIDO 's Global Chemical Leasing Programme is based on the preventive Resource Efficient and Cleaner Production (RE CP) concept and stands as an example for UNIDO 's approach of counteracting the negative effects of industry on the environment while maintaining competitiveness and enabling sustainable growth. Chemical Leasing is UNIDO 's response to the unsustainable management of chemicals in industries and lack of cooperation among chemicals producers and users." [46]

"With the support of the Government of Austria, in 2004 UNIDO introduced Chemical Leasing, a business model that marks a paradigm shift from the selling of chemical goods to the delivery of chemical services, leading to a more efficient use of chemicals."[49]

Chemical Leasing

In 2008 UNIDO defined 'Chemical Leasing' jointly with an international working group as follows:

"Chemical Leasing is a service-oriented business model that shifts the focus from increasing sales volume of chemicals towards a value-added approach. The producer mainly sells the functions performed by the chemical and functional units are the main basis for payment.

Within Chemical Leasing business models the responsibility of the producer and service provider is extended and may include management of the entire life cycle. Chemical Leasing strives for a win-win situation. It aims at increasing the efficient use of chemicals while reducing the risks of chemicals and protecting human health. It improves the economic and environmental performance of participating companies and enhances their access to new markets.

Key elements of successful Chemical Leasing business models are proper benefit sharing, high quality standards and mutual trust between participating companies."

Source: UNIDO: Global Promotion and Implementation of Chemical Leasing Business Models in Industry, 10 Years Report and Strategy Outlook. Vienna, 2016

[49] http://www.unido.org/chemical-leasing.html

"The concept encourages sound chemicals management based on long-term partnerships, fosters innovation and promotes sustainable production and consumption patterns. With the experiences gained over the years, an online-based Chemical Leasing Toolkit was developed to support technicians, business-persons and policy-makers in the implementation and integration processes at different levels (http://www.chemicalleasing-toolkit.org). The Chemical Leasing Toolkit provides guidelines, materials, best practice case studies and lessons learnt from 10 years of work at UNIDO's Global Chemical Leasing Programme."[50]

In UNIDO's Chemical Leasing Strategy [2015 – 2025], "for the first time, a vision has been defined for the Global Programme, highlighting the strong linkage between the Programme, the newly adopted UN Sustainability Agenda 2030 and the corresponding Sustainable Development Goals, in particular, SDG 9.

Chemical Leasing is a mainstream, state-of-the-art business model widely used for contracts in industry, services and public procurement. The use of Chemical Leasing contributes to Inclusive Sustainable Industrial Development by helping to safeguard the environment and people, creating shared prosperity for the partners and encouraging innovation." [46]

Homepage: http://www.chemicalleasing.org

5.1.3.2 Criteria

"Five criteria were formulated by international Chemical Leasing experts as a result of the first national Chemical Leasing initiative driven by the German Federal Environment Agency in 2009.

- Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes
- Improved handling and storage of chemicals to prevent and minimize risks
- No substitution of chemicals by substances with a higher risk
- Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners
- Monitoring of the improvements needs to be possible"[51]

Table 12 gives a survey on the check list with reference to critical aspects to be considered, like e.g. measuring and monitoring of the improvement gained.

From 2004 to 2014, a broad range of projects has been realized in Brazil, Colombia, Costa Rica, Croatia, Ecuador, Egypt, Mexico, Nicaragua, Russia, Serbia, Sri Lanka, Uganda and Ukraine with more than 50 partner companies (users or suppliers). [46]

Table 12: UNIDO: Chemical Leasing Sustainability Criteria Check List

Chemical Leasing Sustainability Criteria Check List	*YES, the case complies*	*NO*	*DETAILS*

[50] Schwager, P., Decker, N., Kaltenegger, I. (2016): Exploring Green Chemistry, Sustainable Chemistry and innovative business models such as Chemical Leasing in the context of international policy discussions, Current Opinion in Green and Sustainable Chemistry, Volume 1, August 2016, Pages 18-21, ISSN 2452-2236, http://dx.doi.org/10.1016/j.cogsc.2016.07.005. http://www.sciencedirect.com/science/article/pii/S2452223616300062

[51] http://www.chemicalleasing.org/concept/sustainability-criteria

Criterion I – Reduction of energy and resource consumption and minimization of adverse impacts on the environment and health caused by chemicals, their application and production processes			
Please take into consideration the following issues:			
• Reduced environmental impact measurable by reduced material flows (including waste and emissions generated and energy savings) and compared to the situation before Chemical Leasing. For the overall balance, the manufacture of chemicals and the impact of equipment and machinery also need to be considered.			
• Reduced impact on health (reduced exposure to chemicals and/or reduced hazardousness of chemicals used) measurable by material flow analyses and hazardousness classification (GHS).			
Criterion II – Improved handling and storage of chemicals to prevent and minimize risks			
Please take into consideration the following issues:			
• Reduced risks due to improved handling and storage as a consequence of the increased collaboration between user and supplier. Since measurements are difficult to perform, a qualitative description is necessary for actions regarding the prevention and/or reduction of risks. This can be carried out by means of classical risk assessment, i.e. describing the probability of accidents and their potential impacts.			
• Apart from improvements in the environmental situation and health issues, economic impacts (change of liability for Chemical Leasing partners) might also be relevant. This can be checked in the contract.			
Criterion III – No substitution of chemicals by substances with a higher risk			
Please take into consideration the following issues:			
• Contradictions in terms of sustainability can occur if chemicals are substituted by substances that pose a higher risk for the environment and health.			
• Experience has shown that this criterion does not apply to many pilot projects (no substitution intended). In cases where chemicals are substituted, it needs to be determined at which level higher risks occur for the environment and health (references might be REACH/GHS classifications and exposure data). For the risk assessment, the exposure (real and potential) as well as the hazardousness of the substance need to be considered.			
Criterion IV – Generation of economic and social benefits, continuous improvement and fair sharing of the benefits between the partners			
Please take into consideration the following issues:			
• Economic benefits for both partners are essential if the contract is to continue and for the success of Chemical Leasing as a business model. Economic improvements are relatively easy to quantify.			
• Typical social benefits include better working conditions. It is not the aim of Chemical Leasing to increase the efficiency of processes by reducing the number of jobs involved.			
• The objective of continuous improvement as well as the fair and transparent sharing of benefits between the partners should be included in the Chemical Leasing contract.			
Criterion V – Providing for the possibility to monitor improvements			
Please take into consideration the following issues:			
• • Highly relevant for most pilot cases;			
• • Easy to check whether the data corresponds to that fixed in the contract; important to check whether fully implemented.			
Challenges:			
• Agreeing on specific monitoring measures with sufficient transparency and acceptable levels of work involved.			
• Preservation of confidentiality when monitoring sensitive data.			

Source: UNIDO: Global Promotion and Implementation of Chemical Leasing Business Models in Industry, 10 Years Report and Strategy Outlook. Vienna, 2016
http://www.chemicalleasing.org/sites/default/files/20160310_10%20Years%20Chemical%20Leasing%20Report%20and%20Strategy%20Outlook_FV.pdf

5.1.3.3 Evaluation

In 2014, Moser et al. analyzed if and how the application of chemical leasing promotes sustainability in comparison to an existing chemicals production and management system. The proposed methodology includes four basic goals and 26 sub-goals to assess the sustainability (Table 13). Using these criteria, the authors analyzed eight different chemical leasing case studies that have been implemented both at the local and the national levels. [52]

Table 13: Conceptual framework outlining basic goals and related sub-goals for promoting sustainable chemistry through chemical leasing [Moser et al., 2014]

Basic goals (g_i)		Sub-goals (g_{ij})	
g_1	Increase overall resource efficiency	$g_{1,1}$	Use less energy
		$g_{1,2}$	Use less raw and auxiliary materials
		$g_{1,3}$	Use less water
		$g_{1,4}$	Produce less waste/wastewater
g_2	Reduce adverse effects on health and environment of the chemicals of concern	$g_{2,1}$	Reduce impacts on labour health
		$g_{2,2}$	Substitution of carcinogenic, mutagenic and toxic for reproduction (CMR) chemicals
		$g_{2,3}$	Substitution of persistent, bioaccumulative and toxic (PBT) chemicals
		$g_{2,4}$	Reduce impacts on water
		$g_{2,5}$	Reduce impacts on air
		$g_{2,6}$	Reduce impacts on soil
g_3	Increase economic value and strengthen chemicals management	$g_{3,1}$	Increase output with desired properties
		$g_{3,2}$	Optimise handling/storage/logistics
		$g_{3,3}$	Increase economic gain: increase revenue for supplier
		$g_{3,4}$	Increase economic gain: increase revenue for user
		$g_{3,5}$	Increase competiveness for supplier
		$g_{3,6}$	Increase competiveness for user
g_4	Increase sustainability in surrounding systems	$g_{4,1}$	Use less fossil resources
		$g_{4,2}$	Reduce impacts on health of consumers
		$g_{4,3}$	Promote recycling/use in cascades
		$g_{4,4}$	Increase economic gains in the region/country: increase revenue for trade
		$g_{4,5}$	Increase economic gains in the region/country: increase revenue for other stakeholders in the supply chain

[52] Moser, F., Karavezyris, V., Blum, C.: Chemical leasing in the context of sustainable chemistry. Environmental Science and Pollution Research 22(9). December 2014, DOI: 10.1007/s11356-014-3926-0. https://www.researchgate.net/profile/C_Blum/publication/269169310_Chemical_leasing_in_the_context_of_sustainable_chemistry/links/5583c91e08ae89172b85f296/Chemical-leasing-in-the-context-of-sustainable-chemistry.pdf

Basic goals (g_i)	Sub-goals (g_{ij})	
	$g_{4,6}$	Reduce poverty in the region
	$g_{4,7}$	Increase employment in the region
	$g_{4,8}$	Reduce impacts on water in the region
	$g_{4,9}$	Reduce impacts on air, including reduction of greenhouse gases
	$g_{4,10}$	Reduce impacts on ecosystems/biodiversity

Source: Moser, F., Karavezyris, V., Blum, C.: Chemical leasing in the context of sustainable chemistry. Environmental Science and Pollution Research 22(9), December 2014,DOI: 10.1007/s11356-014-3926-0.

For three sub-goals, all listed under basic goal 4 on increasing sustainability in surrounding systems, the authors were not able to derive any data at all. These are a possible increase of revenues for trade ($g_{4,4}$) and for other stakeholders in the supply chain ($g_{4,5}$) in the region or country and the reduction of impacts on air, including greenhouse gases ($g_{4,9}$). "The fact that no data are available for these three sub-goals can be best explained with the apparent shortcoming in the impact assessment of chemical leasing in surrounding systems. Future research is necessary to investigate whether this is due to a lack of funding to undertake such assessment or whether other reasons, such as flaws in the current assessment approaches, hampers the collection of such data."[52]

The authors conclude: "The findings of our assessment demonstrate that chemical leasing can be regarded as promoting sustainable chemistry in five (author's note: of the eight analyzed) case studies with certainty."[52]

Schwager et al. point to the potential of Chemical Leasing for the dissemination of Green Chemistry and Sustainable Chemistry: "Chemical Leasing can encourage better cooperation among partners, stimulate innovation, and incentivize environmentally-benign chemicals management in the future. Chemical Leasing is an innovative and circular economy business model that can accelerate Green Chemistry and Sustainable Chemistry integration within international policy regimes and advance the integration of the three dimensions of sustainable development in chemicals businesses in pursuit of a circular and greener economy. By means of up-scaling and mainstreaming, sector-specific approaches, activities to achieve market change and enhanced policy integration, Chemical Leasing could eventually become a significant factor to foster the sorts of long-term, multistakeholder partnerships that are fundamental to the achievement of lasting change in the area of inclusive and sustainable industrial development."[50]

Table 14: Evaluation of UNIDO's Chemical Leasing approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	Consistent referring to the triple bottom line approach; covers broad parts of the concept of sustainable chemistry defined by the German Environment Agency (Table 9), like improvement of resource efficiency and risk minimization, environmentally friendly production and use of chemicals including, for example, the prevention of pollution and waste, the inclusion of the entire life cycle of a product …
Consistency of indicator concept and how it is monitored	Indicator concept is consistent, following Blum et al.[52]; only few data gaps. Monitoring is part of the contract (see check list, Table 12). In practice, it depends on the details of the CL contract.
Role of SDGs in the concept	"Strong linkage between the Programme, the newly adopted UN Sustainability Agenda 2030 and the corresponding Sustainable

Subject	Comment
	Development Goals, in particular, SDG 9" [46]
Probability of implementation	Implemented in many countries
Overall impression	Valuable tool for implementing sustainable chemistry

Source: Own compilation

5.1.4 UNIDO's green industry initiatives: TEST (Transfer of Environmentally Sound Technologies) and MED TEST (TEST in the Mediterranean Region)

"The Transfer of Environmentally Sound Technology (TEST) is the UNIDO programme to harness the full potential of industry's contribution to Inclusive and Sustainable Industrial Development. TEST is a skill development programme and an integrated approach aimed at improving competitiveness and environmental performance of the industrial sector." [53]

"The TEST methodology aims to improve environmental management and competitiveness of companies (primarily SMEs) in developing countries and economies in transition." [54]

"TEST combines the essential elements of tools such as Resource Efficiency & Cleaner Production (RECP), Environmental Management Systems (EMS) and Material Flow Cost Accounting (MFCA) as part of Corporate Social Responsibility (CSR), applied on the basis of a comprehensive diagnosis of enterprise needs (Initial Review). As a result of the customized integration and implementation of these tools and their elements, the key output is the adoption of best practices, new skills and management culture, enabling the company to carry on the improvement journey towards sustainable entrepreneurship.

TEST builds on management of change and addresses not only the operational level of a business, but also the managerial and strategic levels, along the following lines:

- At the operational level, TEST gives priority to resource efficiency & pollution prevention techniques (RECP) in existing production processes and product design, followed by transfer of cleaner technologies and pollution control solutions (end-of-pipe). Existing processes are optimized by implementing no-cost & low-cost measures with a short pay-back period (PBP), before a portfolio of high investment needing measures is put in place.
- At the level of management systems, EMS and MFCA tools are used to establish the necessary information management system on relevant material, water, energy and related financial flows in order to link the strategic and operational level of the business. The MFCA tool reveals to top management the real costs of production, including hidden environmental costs like non-product output costs. The EMS provides procedures and resources to ensure that the outputs of the RECP audit are implemented, sustained and further developed.
- At the strategic level, TEST places environmental management within the broader strategy of environmental and corporate social responsibilities (CSR) by leading companies towards the adoption of sustainable enterprise strategies." [53]

"The first TEST pilot program was launched in 2000 in the Danube River Basin. Since then, TEST has been replicated in several Regions worldwide within industrial hot spots areas, contributing to prevent discharge of industrial effluents into international waters (rivers, lakes, wetlands and coastal areas) and thereby protecting water resources for future generations.

[53] http://www.weitz-center.org/test-methodology.html

[54] Carolina Gonzalez: UNIDO TEST Methodology. Solutions Forum II – Clean Technologies for Green Industry. 29 October 2013, Nairobi, Kenya. http://ssc.undp.org/content/dam/ssc/documents/Expo/2013/solutionforum/Solution%20Forum%202%20-%20UNIDO/UNIDO%20-%20Clean%20Tech%20for%20Green%20Industry%20.pdf

In 2009 UNIDO launched the MED TEST initiative with the financial support of the GEF and the Italian government to promote the transfer and adoption of cleaner technology in industries of the Southern Mediterranean Region." [55]

Table 17 compiles the results achieved during the implementation of MED TEST in three countries of the South Mediterranean Region: Egypt, Morocco and Tunisia. Only in Egypt, companies from the chemical sector were involved, but in all countries downstream users were involved, too. Success indicators are PBP (pay-back period) and Estimated Environmental Benefits.

Table 15: UNIDO: Results of the implementation of MED TEST in three countries of the South Mediterranean Region: Egypt, Morocco and Tunisia

Subject	Egypt	Morocco	Tunisia	Total
Number of companies, of them	13	11	15	39
# Food (& Beverage) Sector	*4*	*5*	*6*	*15*
# Textile Sector, Finishing	*-*	*2*	*6*	*8*
# Chemicals, Petrochemicals and Petroleum Sector	*5*	*-*	*-*	*5*
# Leather Sector, Tanneries	*1*	*-*	*3*	*4*
# Pulp and Paper Sector	*3*	*-*	*-*	*3*
# Metal Sector	*-*	*2*	*-*	*2*
# Ceramic Sector	*-*	*2*	*-*	*2*
Number of measures, of them	252	280	232	764
# implemented	*79 %*	*85 %*	*63 %*	*76 %*
# retained for further assessments	*13 %*	*8 %*	*20 %*	*14 %*
# discarded	*8 %*	*7 %*	*18 %*	*10 %*
Investments [million US-$/yr]	9.116	4.228	4.457	17.8
Savings [million US-$/yr]	9.131	5.899	3.289	18.3
PBP (pay-back period)				
# < 0.5 years	63 %	40 %	40 %	54 %
# 0.5 – 1.5 years	20 %	25 %	25 %	23 %
# 1.5 – 4 years	17 %	35 %	35 %	23 %
Estimated Environmental Benefits				
# Water savings [million m^3/ yr]	8.88	0.154	0.65	9.7
# Energy savings [GWh/yr]	212.6	18.0	25.1	255.9
# BOD_5 Reductions [1,000 tons/yr]	1.628	-	1.610	3.24
# COD Reductions [1,000 tons/yr]	1.773	-	2.762	4.54

Own compilation. Source: UNIDO: MED TEST. Transfer of Environmental Sound Technology in the South Mediterranean Region. Project Summary and Achievements.

[55] UNIDO: MED TEST. Transfer of Environmental Sound Technology in the South Mediterranean Region. Project Summary and Achievements. http://www.unido.org/fileadmin/user_media/Services/Environmental_Management/Water_Management/Carolina/MEDTEST_%20Brochure_%20English.PDF

http://www.unido.org/fileadmin/user_media/Services/Environmental_Management/Water_Management/Carolina/MEDTEST_%20Brochure_%20English.PDF

As Table 17 shows, there are no indicators concerning social/societal aspects included. But the follow-up programme SwitchMed, launched in october 2015, will probably resolve this deficit[56]: "SwitchMed is an initiative that supports and connects stakeholders to scale-up social and eco innovations in the Mediterranean."

Due to the limited nature of the available data, the assessment shown in Table 18 is to be regarded as conditional.

Table 16: Evaluation of UNIDO's TEST methodology and SWITCHMED project

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	Consistent with UNIDO's triple bottom line approach
Consistency of indicator concept and how it is monitored	Selected indicators for economic and ecological aspects; social/societal indicators are lacking.
Role of SDGs in the concept	Several links on https://www.switchmed.eu/en
Probability of implementation	Implemented in some countries
Overall impression	Valuable tool for capacity building

Source: Own compilation

5.1.5 UNIDO's Responsible Entrepreneurs Achievement Programme (REAP)

"The Responsible Entrepreneurs Achievement Programme (REAP) is a CSR-based management and reporting tool. It was developed by UNIDO to assist Small and Medium Enterprises (SMEs) in their efforts to implement CSR-based management approaches and operation methods, thereby aligning economic, social and environmental aspects of business (also referred to as "Triple Bottom Line Approach").

Based on the Ten Principles of the UN Global Compact, as well as international standards in the social and environmental domains, such as ISO 14001, SA 8000, or OHSAS 18001, it provides a structured framework in combination with an analytical software, which can be used to gather, process, evaluate and report data to track progress in implementing CSR in SMEs." [57]

"REAP is based on the following approaches:

- Triple-Bottom-Line (TBL) Approach, which combines economic, environmental and social data in an assessment of a company's achievements
- 5S methodology for enhancing workplaces and process efficiency (productivity upgrading)
- Total Employee Involvement (TEI) Concept to allow for continuous improvement
- UN Global Compact (10 principles of responsible business conduct), covering Human Rights, Labour Standards, Environment and Anti-Corruption
- Other international standards such as ISO 26000, ISO 14001, SA 8000, OHSAS 18001, etc.

[56] „SwitchMed is collaboratively coordinated by the EU, United Nations Industrial Development Organisations (UNIDO), United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP), its Regional Activity Centre for Sustainable Consumption and Production (SCP/RAC) and the UNEP-DTIE (Division of Technology, Industry and Economics)." https://www.switchmed.eu/en/about-us

[57] https://www.unido.org/reap.html

- Best practices in Responsible Supply Chain Management"[58]

"CSR issues that can be tackled through REAP:

- Environmental: environmental management (basics), water, energy, waste, and raw material management, requirements for ISO 14001
- Social: employee satisfaction, working hours, wages, disciplinary measures, health and safety, child labour, forced and bonded labour, freedom of association, discrimination, harassment and abuse
- Anti-corruption"[59]

CSR case studies are availabe for companies from Croatia (2006)[60] or from India, Pakistan, Sri Lanka and Thailand (2003)[61]. For instance, for companies from Croatia, the indicators for measuring progress are shown in Table 17.

Table 17: UNIDO: Measuring progress in CSR of four Croatian companies[60]

Subject	Company			
	A	B	C	D
Productivity		n.a.		
Rejected product (% or m^2)	X		X	X
Customer complaints (n =)			X	X
Breakdowns (%)	X			
Deliveries on time (%)			X	
Production capacity (m^2/hour)				X
Social domain				
Implemented measures (n =)	X	X	X	X
Over-time (number of over-time hours/total number of working hours)	X	X	X	
Employees' level of satisfaction	X		X	X
Accident frequency (Number of accidents per 1,000 days worked/number of permanent employees)		X		
Working days lost (Number of days lost (accidents, sickness, others)/total number of working days)			X	
Level of noise (dB)	X			
Salary increase (net monthly salary) (Croatian Kuna, HRK)	X			
Environment				
Energy consumption (kWh/t or kWh/working hour or kWh/m^2)		X	X	X
Waste generation (kg/t or kg/m^2)	X	X		X
Water consumption (m^3/t or m^3/working hour)		X	X	
Hazardous waste (kg/1,000 m^2)				X
Waste selection (number of containers; n =)			X	

[58] https://www.unido.org/reap/what-is-reap.html
[59] https://www.unido.org/reap/methodology.html
[60] https://www.unido.org/fileadmin/user_media/Services/PSD/CSR/Companies_results_Croatia.pdf
[61] https://www.unido.org/fileadmin/user_media/Services/PSD/CSR/Case_studies_-_SE_Asia_TBL_Project.pdf

Subject	Company			
	A	B	C	D
Total Suspended Solid (TSS) (mg/l)	X			
Toluene recuperation (%)	X			

Own compilation, sourcing UNIDO's CSR case study report for companies in Croatia (undated)
https://www.unido.org/fileadmin/user_media/Services/PSD/CSR/Companies__results_Croatia.pdf

Due to the limited nature of the available data, the assessment shown in Table 18 is to be regarded as conditional.

Table 18: Evaluation of UNIDO's Responsible Entrepreneurs Achievement Programme (REAP)

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	Consistent with UNIDO's triple bottom line approach
Consistency of indicator concept and how it is monitored	Indicators are taylor-made for SMEs, therefore only selected indicators reported, e.g. no information on gender aspects or anti-corruption
Role of SDGs in the concept	The SDGs have not been addressed, as the programme run in the first decade of this millennium.
Probability of implementation	Implemented in some countries
Overall impression	Valuable tool for implementing sustainable chemistry at the SME-level

Source: Own compilation

5.2 OECD Sustainable Chemistry Platform (SCP)

The Organisation for Economic Co-operation and Development (OECD) has been working for nearly 20 years on the issue of sustainable chemistry: "The OECD's work on Sustainable Chemistry was initiated in 1998. The Issue Team on Sustainable Chemistry was established in 1999 and focused largely on developing guidance for "Establishing Research and Development Programmes in Sustainable Chemistry".

In 2004 the German Environment Agency (UBA) jointly with the Organization for Economic Cooperation and Development (OECD) developed qualitative and quantitative criteria for sustainable chemistry [Blum et al., 2017]. In 2006, the Issue Team established a Sustainable Chemistry Network for information exchange, review of new developments and further elaboration of incentives for sustainable chemistry. In 2007, the Issue Team started to develop a Sustainable Chemistry Platform to serve as a networking resource and a place to disseminate information about workshops, training courses, and other capacity building opportunities."[62]

OECD has made a clear distinction between sustainable chemistry and green chemistry: [62]

- "Green Chemistry is an approach to chemical synthesis that considers life cycle factors like waste, safety, energy use and toxicity in the earliest stages of molecular design and production, in order to mitigate environmental impacts and enhance the safety and efficiency associated with chemical

[62] The Role of Government Policy in Supporting the Adoption of Green/Sustainable Chemistry Innovations ENV/JM/MONO(2012)3.
http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2012)3&doclanguage=en

production, use, and disposal. It takes a life cycle approach to minimize undesirable impacts that can be associated with chemicals and their production."

- "Sustainable chemistry is a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services. … 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 points out that "in general, there is still lack of knowledge and awareness of Sustainable Chemistry. So far, efforts to make chemicals production and use more sustainable have focused on specific chemicals or processes. Historically, much of the focus has been on identifying substitutes. Today there is also active research into alternative technologies and chemical synthesis techniques that can address many issues simultaneously. There is no doubt that progress towards sustainable chemistry is an emerging trend, but it is also clear that there are many challenges ahead."[63]

"Recent OECD work in this area has focused on developing a better understanding of what drives sustainable chemistry innovation and on establishing a web-based **Sustainable Chemistry Platform** to serve as a networking resource and a place to disseminate information about workshops, training courses, and other capacity building opportunities." [64]

The Sustainable Chemistry Platform is part of the OECD's work on chemical safety and biosafety carried out under the Environment, Health and Safety (EHS) Programme; its secretariat is the EHS Division in the Environment Directorate. The organizational chart of the Environment Policy Committee (EPOC) is shown in Figure 2.

"The (EHS) Programme is overseen by the "Joint Meeting" which comprises the EPOC Working Party on Chemicals, Pesticides and Biotechnology and the Chemicals Committee. The Chemicals Committee, like the Environment Policy Committee (EPOC), reports directly to the OECD Council. The work of the Chemicals Committee is largely funded by a specific (Part II) budget, separate from the regular OECD budget.

The Joint Meeting of the Chemicals Committee and Working Party on Chemicals, Pesticides and Biotechnology oversees eleven main subsidiary bodies called Working Parties, Working Groups or Task Forces. In addition, in order to continue specific work that needs input from experts, the Joint Meeting and its Working Groups establish various sub-groups with specific time-limited mandates, such as Expert Groups, Steering Groups, Expert Panels, and **Issues Teams** to study specific issues, to oversee defined projects, or develop proposals. Non-member economies and stakeholder partners also participate in the activities of the EHS Programme."[65]

The Issue Team on Sustainable Chemistry is one of the three main sub-bodies of the Risk Management Programme.[66] Further details can be found in Table 19. Information was mainly sourced from the Sustainable Chemistry Platform's website [64].

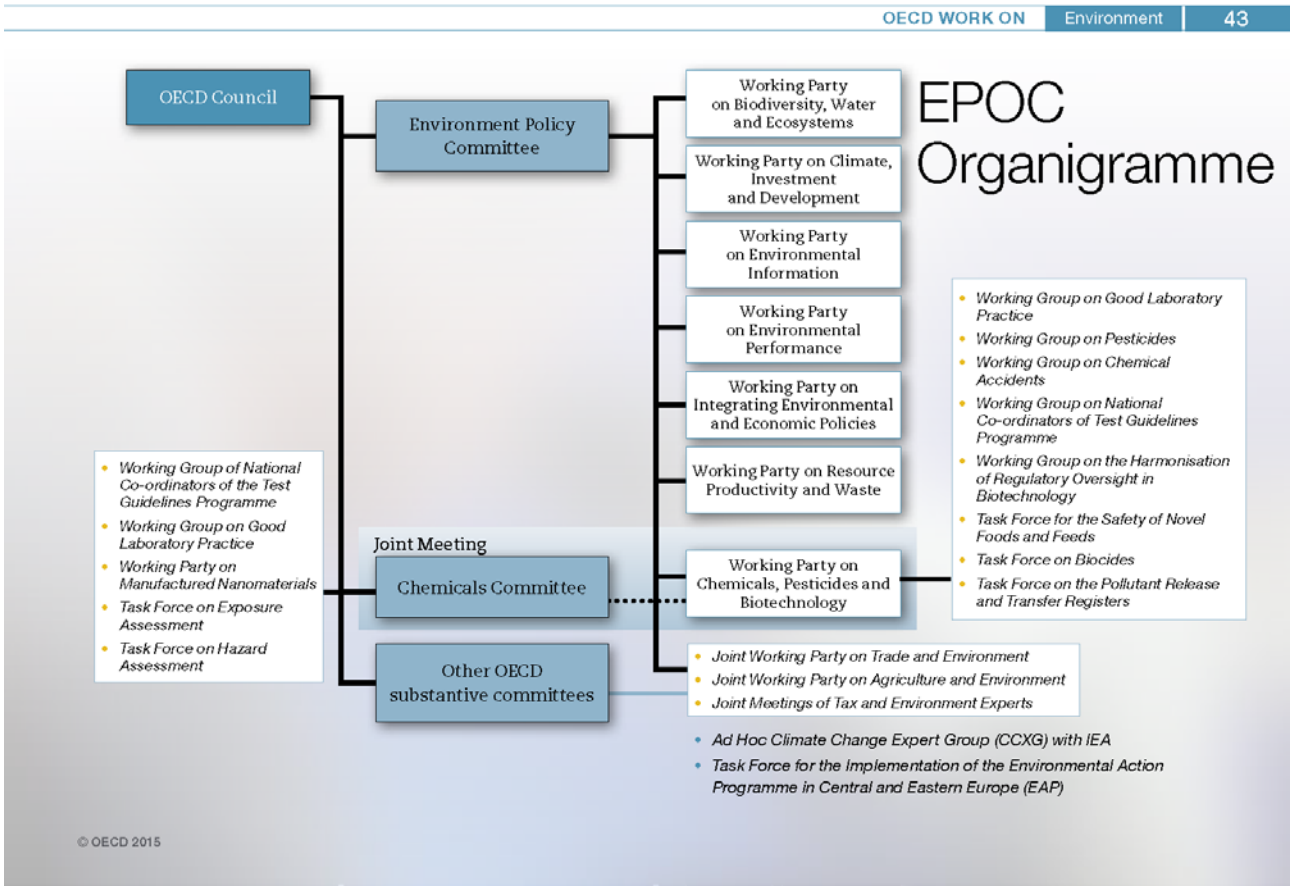
[63] http://51938654.de.strato-hosting.eu/department/introduction.html

[64] http://www.oecd.org/env_sustainablechemistry_platform/

[65] http://www.oecd.org/env/ehs/organisationoftheenvironmenthealthandsafetyprogramme.htm

[66] http://www.oecd.org/env/ehs/risk-management/

Figure 2: OECD: Organizational chart of the Environment Policy Committee (EPOC)



Source: OECD http://www.oecd.org/env/2015-EPOC-Organigramme.pdf

Table 19: OECD: Short Characterization

Subject	Information
Name	**OECD**
(Main) URL	http://www.oecd.org/env_sustainablechemistry_platform/
Type of organisation	International organization
Coverage/region	Global
Institution(s) behind initiative/approach	OECD/ OECD's EHS Division in the Environment Directorate
Legal information	International organization (founded 1961)
Governance bodies	"Overseeing": "Joint Meeting", comprising the Environment Policy Committee's (EPOC) Working Party on Chemicals, Pesticides and Biotechnology and the Chemicals Committee. Both committees report directly to the OECD Council. Secretariat: EHS Division in the Environment Directorate; head: Bob Diderich
President/CEO/Chairman	Angel Gurría, Secretary-General of the OECD
Year of foundation	OECD Sustainable Chemistry Platform (SCP): 2007
Budget/funding	Funded by a specific (Part II) budget, separate from the regular OECD budget
Links/closeness to other stakeholders	Several networks for green or sustainable chemistry listed[67]
Target audience and sectoral/geographical scope	Government, academia, industry and NGOs; international
Self-declared goal	"This site was set up to facilitate information exchange, review of new developments and further elaboration of incentives for Sustainable Chemistry and to facilitate networking of stakeholders. This platform intends to identify specific areas and projects of Sustainable Chemistry that would benefit from international co-operation (e.g. chemical leasing and sustainable products from nanotechnology)."
Definition of sustainable chemistry resp. sustainability	"Sustainable chemistry is a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services. … 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."[62]

[67] http://51938654.de.strato-hosting.eu/department/networks.html

Subject	Information
	"Sustainable chemistry encompasses the design, manufacture and use of efficient, effective, safe and more environmentally benign chemical products and processes."[64]
Concept of selected indicators	**Methods for assessing sustainable chemistry products and processes:** Such fundamental criteria should include the following factors: 1. Determination of the impact on human health and the environment; 2. Determination of the safety of workers or users throughout the production processes or life cycle of products; 3. A comprehensive evaluation of energy consumption and resource use; and 4. An evaluation of each of the above factors (1-3) conducted at the local, country/regional or global levels. Based on these fundamental criteria, e**ach country or organization needs to establish its own specific criteria** that reflect its particular situation.[68]
Launch year, change in concept (if any) since then	n.a.
Proposed instruments and measures for implementation	"In this respect, OECD can provide general and fundamental criteria (and methods) which can help countries and regions develop their own more specific assessment criteria. One practical approach for developing general criteria is to extract essential indices by categorising the factors that are raised by experts. For instance, these criteria or factors can be collected from countries that have sustainable chemistry award programmes and use such criteria to identify candidates and select winners. The criteria and assessment methods should be sufficiently flexible so that countries and organisations can modify the methods when they gain experience." [68]
Status of implementation (e.g. description of best practice, etc.)	2002: Examples of Green Chemistry awards from different countries [68]
Status and type of monitoring including e.g. time series of indicator measurements	n.a. Latest report on the Reports on sustainable chemistry page (http://www.oecd.org/env/ehs/risk-management/reports-on-sustainable-chemistry.htm): 2011: ENV/JM/MONO(2011)4 (dead link) Latest workshop on Green Chemistry on the Workshop page (http://51938654.de.strato-hosting.eu/department/workshops.html): 2012
Stakeholder dialogue	"The Joint Meeting recognises the valuable contribution that non-governmental organisations make to EHS issues and attaches great importance to working with them. Representatives of environmental NGOs, business, and trade unions participate as invited experts in the Joint Meeting and subsidiary bodies, and in a range of activities under the Joint Meeting, including various expert meetings, conferences, workshops, etc.

[68] OECD, ENVIRONMENT DIRECTORATE: NEED FOR RESEARCH AND DEVELOPMENT PROGRAMMES IN SUSTAINABLE CHEMISTRY. OECD Environment, Health and Safety Publications Series on Risk Management, No. 15. ENV/JM/MONO(2002)12 http://www.oecd.org/env/ehs/risk-management/42784720.pdf

Subject	Information
	Industry participation in Joint Meeting activities is organised by the Business and Industry Advisory Committee to the OECD (BIAC), while trade union representation is organised by the Trade Union Advisory Committee to the OECD (TUAC). The participation of environmental NGOs across the OECD is coordinated by the European Environmental Bureau (EEB). The International Council for Animal Protection in OECD Programmes (ICAPO) participates as invited experts in meetings where issues relating to animal welfare are discussed." [69]
Additional information	OECD's focus on chemicals' safety currently lies on Manufactured Nanomaterials.[70]

Own compilation, using the following sources: OECD Sustainable Chemistry Platform (SCP) and
OECD, ENVIRONMENT DIRECTORATE: NEED FOR RESEARCH AND DEVELOPMENT PROGRAMMES IN SUSTAINABLE CHEMISTRY. OECD Environment, Health and Safety Publications Series on Risk Management, No. 15. ENV/JM/MONO(2002)12
http://www.oecd.org/env_sustainablechemistry_platform/
http://www.oecd.org/env/ehs/risk-management/42784720.pdf

5.3 Interim conclusion on UNIDO and OECD approach

The OECD has set standards with its definition of sustainable chemistry, and is used as reference e.g. by SusChem or UNIDO. The OECD description of sustainable chemistry has a strong perception because of the particular role of this international organization in providing science-based tools for policy-making [Blum et al., 2017].

UNIDO's four projects selected for evaluation show that their concepts cover broad parts of the concept of sustainable chemistry defined by the German Environment Agency, like improvement of resource efficiency, environmentally friendly production and use of chemicals, the inclusion of the entire life cycle of a product.

6 (Chemical) Industry organizations and initiatives

In this chapter, chemical industry approaches are presented. There is a grey zone with regard to the demarcation of upstream and downstream approaches, as many chemical companies have various functions. Some of these approaches are presented in chapter 7 "Approaches from the upstream / downstream value chain".

6.1 International Council of Chemical Associations (ICCA): Responsible Care

6.1.1 Characterization

"In the 1980s, pressures to regulate Canada's chemistry industry were growing, galvanized by spills, process safety, and transportation incidents in Canada and abroad" (Seveso, 1976, Bhopal, 1984). "Canada's chemistry CEOs faced the facts: the public did not trust the industry. Building public trust would require something above and beyond the law: a commitment to doing the right thing. Between 1985 and 1988, members of the Chemistry Industry Association of Canada (CIAC, then known as the Canadian Chemical Producers' Association) drafted the first Responsible Care® Codes – including stringent guidelines for the safe and environmentally sound management of chemicals. Those codes

[69] http://www.oecd.org/env/ehs/organisationoftheenvironmenthealthandsafetyprogramme.htm#Stakeholders
[70] http://www.oecd.org/env/ehs/nanosafety/publications-series-safety-manufactured-nanomaterials.htm

remained essentially unchanged for more than two decades."[71] However, Responsible Care did evolve since its first launch in Canada in 1985, has been expanded to more than 60 countries globally and is overseen by the International Council of Chemical Associations (ICCA).

At the UN International Conference on Chemicals Management (ICCM) in February 2006 in Dubai, United Arab Emirates, the Strategic Approach to International Chemicals Management (SAICM) was adopted as a policy framework to foster the sound management of chemicals. Here, ICCA launched its two flagship programs **Global Product Strategy** (GPS) and **Responsible Care** (together with the first Responsible Care Global Charter) as its major contributions to achieving the SAICM 2020 goal that, *"by the year 2020, all chemicals will be produced and used in ways that minimize risks for human health and the environment."* [72] The Responsible Care Global Charter[73] was expanded and extended "the process of continuous improvement beyond chemicals manufacturing to other activities, especially those associated with the safe use and handling of products along the value chain."

"In 2014, the Responsible Care Global Charter was revised and launched publicly at the fourth UN International Conference on Chemicals Management in Geneva in 2015. The revised Responsible Care Global Charter "seeks to harmonize, govern and expand the Responsible Care ethic globally. It added a new focus on product stewardship throughout the supply chain and reinforced continued commitment and contributions to sustainable development." [74] As of December 2016, about 550 chemical companies belonging to ICCA associations, and more than 90% of the world's largest chemical companies, have signed up to the Responsible Care Global Charter."[75]

"Responsible Care is the unifying chemical industry commitment to constantly improve its environment, health, safety and security performance globally by ensuring. National Responsible Care associations provide guidance and support to their member companies in implementing respective measures to ensure safe chemicals handling throughout their lifecycle. ICCA and its members monitor, benchmark and communicate chemical industry achievements at the local, national, regional and global levels. Since 2007, ICCA constantly reports on its performance through publically available Responsible Care Reports (2007, 2008, 2009, 2012, 2015) or SAICM reports (2011, 2012, 2013, 2014, 2015). In addition to completing a Responsible Care organization survey which includes details about the program's structure, RCLG associations complete an addition survey on GPS implementation."[75]

Table 20 provides a short description of ICCA. Information was mainly sourced from ICCA's[76] and CEFIC's websites[77].

Table 20: International Council of Chemical Associations (ICCA): Short Characterization

Subject	Information
Name	International Council of Chemical Associations (ICCA)
(Main) URL	https://www.icca-chem.org
Type of organization	"ICCA is a virtual organization, coordinating the work of individuals from member associations and their member companies."
Coverage/region	Global

[71] http://www.canadianchemistry.ca/responsible_care/index.php/en/responsible-care-history

[72] http://icca.cefic.org/en/Home/About-us/Who-we-are/

[73] http://www.cefic.org/Documents/ResponsibleCare/RC_GlobalCharter2006%5b1%5d.pdf

[74] ICCA: 2015 Responsible Care Status Report. http://icca.cefic.org/ICCADocs/RC%20report%202015%20FINAL%20LRspread.pdf

[75] ICCA, personal communication, 19.1.2017

[76] https://www.icca-chem.org

[77] http://icca.cefic.org/

Subject	Information
Institution(s) behind initiative/approach	ICCA members (incl. observers & Responsible Care members) account for more than 90 percent of global chemical sales. In order to become a member of ICCA, the organization must (amongst others) be the leading association/federation in the country or region and committed to meeting all the criteria for full membership within a five-year timeframe. Its members are both regional trade associations, such as CEFIC or the Gulf Petrochemicals and Chemicals Association, and also national associations including the American Chemistry Council.
Legal information	ICCA is a council of leading trade associations which represent chemical manufacturers worldwide. "Responsible Care is the trademark name for the chemical industry's voluntary, global initiative to realize its commitment to continuous improvement in all aspects of environmental, health, and safety (EHS) performance and to openness in communication about its activities and its achievements."[78]
Governance bodies	**Global Executive Strategy Group**, consists of leading chemical industry CEOs. The Group provides guidance and recommendations to the Board of Directors on strategic direction and priorities, provides leadership on key ICCA initiatives, and engages in outreach. **Board of Directors**, representing member associations, a maximum of 25 CEOs from companies belonging to ICCA associations, representative of the membership and reflecting a regional balance. **President**, head of the Board, is the private sector CEO who chairs the association currently serving as the ICCA Secretariat. The Secretariat rotates every two years among the major associations Cefic and ACC; it is led by a **Council Secretary**, who chairs the Steering Committee, and is the head of the association currently serving as Secretariat. **Steering Committee**, responsible for supervision of several working level groups, chaired by the Council Secretary. **Responsible Care Leadership Group (RCLG)**, manages the Responsible Care initiative at the global level. [79]
President/CEO/Chairman	Kurt Bock, BASF SE, Chair of the Global Executive Strategy Group Mark Rohr, Celanese, ICCA President (from 2017 onwards Hariolf Kottmann, Clariant) Council Secretary: Cal Dooley, ACC (from 2017-2019: Marco Mensink, Cefic)
Year of foundation	ICCA: 1989 ICCA started overseeing Responsible Care in 2006; initial launch by Canadian Association in 1985
Budget/funding	n.a.

[78] http://hrlibrary.umn.edu/links/iccastatusrpt.html

[79] http://icca.cefic.org/en/Home/About-us/The-structure-of-the-ICCA/?disp=lst&section=2164

Subject	Information
Links/closeness to other stakeholders	ICCA and its members cooperate in a number of projects with intergovernmental organizations, e.g. UNEP (United Nations Environment Programme), UNITAR (United Nations Training & Research Program) and OECD (Organisation for Economic Co-operation & Development).
Target audience and sectoral/geographical scope	ICCA is operating globally and aims to support all entities handling chemicals to safely manage chemicals across their life cycle. Through the two flagship programs Responsible Care and the Global Product Strategy, chemical industry continuously improves its safety, health, environmental and security performance and provides "an effective channel for dialogue, understanding and cooperation between the **industry, governments and other stakeholders**." [73]
Self-declared goal	**Mission**: To "help the global chemical industry improve financial performance and reputation by tackling global issues and by helping the industry to improve continuously its performance through Responsible Care® and other programs." *Approved by the Board of Directors in 2001*
Definition of sustainable chemistry resp. sustainability	"ICCA has participated in a dialogue on sustainable development for many years and. The Charter commits chemical companies and associations to continually advance sustainable development. This consists of a set of policies and practices aimed at achieving economic, environmental, and societal progress that benefits future generations without compromising the needs of the present generation." [73]
Concept of selected indicators	"The Charter metrics will be the same as those that the ICCA has been using for several years." ICCA is collecting a set of 26 KPIs, which includes: "number of fatalities; lost time injuries frequency rate; sulfur oxides; nitrogen oxides; chemical oxygen demand; energy consumption; direct and indirect carbon dioxide; other greenhouse gases; number of incidents; and total water consumption. ICCA periodically reviews these metrics to determine the need for any changes. The national associations will also need to determine what changes, if any, are necessary within their programmes to meet Charter commitments." [73] In addition, ICCA developed a process safety KPI to collect data in a harmonized and transparent way. While associations voluntarily start collecting data 2017, reporting is mandatory by 2020.[75]
Launch year, change in concept (if any) since then	2006: Launch of Responsible Care (RC) and the Global Product Strategy 2008: Launch of the first RC Global Charter 2014: Launch of revised RC Global Charter
Proposed instruments and measures for implementation	Revised Global Charter Responsible Care 2014:[74] CEO signatories to the Charter commit to actively strengthen Responsible Care worldwide by dedicating their company, people, technologies and business practices to these six Key Elements: 1. A Corporate Leadership Culture 2. Safeguarding People and the Environment 3. Strengthening Chemicals Management Systems 4. Influencing Business Partners 5. Engaging Stakeholders 6. Contributing to Sustainability

Subject	Information
Status of implementation (e.g. description of best practice, etc.)	As of December 2016, about 550 chemical companies belong to ICCA associations, with more than 90% of the world's largest chemical companies, having signed up to the 2014 Global Charter. 61 associations from all continents are member of ICCA. [75]
Status and type of monitoring including e.g. time series of indicator measurements	Periodical Responsible Care Status Reports and reports of SAICM indicators: 2012[80], 2015[74] (RC reports), 2007,2008, 2009, 2011, 2012, 2013, 2014, 2015 (SAICM reports)
Stakeholder dialogue	"ICCA also serves as the main channel of communication between the industry and various international entities, such as inter-governmental organizations (IGOs) and NGOs, that are concerned with these global issues."
Additional information	Membership criteria explicitly include the support of the Chemical Weapons Convention.

Own compilation, using the following sources: ICCA's and CEFIC's website. https://www.icca-chem.org and http://icca.cefic.org/

6.1.2 Criteria

ICCA stated: "ICCA has participated in a dialogue on **sustainable development** for many years and **achieved acceptance from the United Nations and other stakeholders for the idea that Responsible Care is the means through which the chemical industry will practice this concept**. … This consists of a set of policies and practices aimed at achieving economic, environmental, and societal progress that benefits future generations without compromising the needs of the present generation."[73]

With reference to this statement, the ten metrics (plus two reference parameters) for measuring chemical industry's progress on a global scale are shown below. ICCA has used these Charter metrics for several years. "ICCA periodically reviews these metrics to determine the need for any changes. The national associations will also need to determine what changes, if any, are necessary within their programmes to meet Charter commitments." [73]

Table 21: International Council of Chemical Associations (ICCA): Responsible Care Charter metrics

Aspect	Indicator(s) of Performance	Reporting associations 2011/2012/2013[1]
Health & Safety	► Number of fatalities. ► Lost time injury rate, expressed as number of lost time accidents with at least one day out of work per million working hours.	► 46 / 46 / 42 ► 43 / 43 / 45
Environment	► Emissions to air: Sulphur dioxide (SO_2) and nitrogen oxides (NO_x), expressed as metric tonnes.	► 51 / 52 / 52
	► Discharges to water: Chemical oxygen demand (COD), expressed as metric tonnes of oxygen.	► 51 / 52 / 52
	► Greenhouse gas emissions, expressed as millions of direct and indirect metric tonnes of CO_2 equivalents emitted.	► 47 / 47 / 47

[80] http://icca.cefic.org/ICCADocs/RC%20annual%20report.pdf

Aspect	Indicator(s) of Performance	Reporting associations 2011/2012/2013[1]
	► Greenhouse gas intensity, expressed as metric tonnes of CO_2 equivalents emitted per million metric tonnes of production. [This KPI is not reported by member federations – FL.[75]]	► 47 / 47 / 47
Resources	► Energy consumption, expressed as metric tonnes of fuel oil equivalent used.	► 33 / 34 / 34
	► Energy intensity, expressed as metric tonnes of fuel oil equivalents used per million metric tonnes of production. [This KPIs is in principle reported by Cefic members, not ICCA.[75]]	► 33 / 34 / 34
	► Water consumption, expressed as millions of cubic meters of water consumed, with returns credited.	► 41 / 42 / 44
Distribution	► Number of transport incidents.	► 33 / 33 / 41
Reference parameters	► Number of employees in the chemical industry reporting ► Annual turnover and production for the chemical industry reporting.	► 52 / 52 / 52 ► 43 / 44 / 44

1 The number of responses between the different indicators changes between the same year as not all member associations have reached the same level of maturity and are not able to collect and report all KPIs.[75]
Own compilation, using the following source: ICCA: 2015 Responsible Care Status Report.
http://icca.cefic.org/ICCADocs/RC%20report%202015%20FINAL%20LRspread.pdf

The Japan Chemical Industry Association (JCIA) has added further metrics, e.g. severity of occupational accidents, release of substances specified in the PRTR Act or implementing measures to conserve biodiversity.[81] The American Chemistry Council (ACC) even offers a tool to compare member companies' individual performance[82].

"Starting in 2016, (the) RCLG (Responsible Care Leadership Group) member associations will be asked to report two (additional) data points to ICCA: 'Total number of Process Safety Events (PSE)' and 'Total employee hours.' This latter data point is already collected under the RCLG performance metric on occupational safety rates. The data will enable calculation of a Process Safety Event Rate (PSER), normalized on a per 100 employee basis." [74]

6.1.3 Evaluation

„Responsible Care is the initiative by the chemical industry to improve its environment, health, safety and security performance and was established way before the adoption of the UN Sustainable Development Goals. However, besides seeking to harmonize, govern and expand the Responsible Care ethic globally, the revised Global Charter also launched a new focus on product stewardship throughout the supply chain as well as on sustainable development. Responsible Care signatories commit to contribute to sustainability through improved performance, expanded economic opportunities and the development of technologies and other solutions to societal challenges. Responsible Care indicators for instance measure the performance with respect to emissions (sulfur dioxide, nitrogen dioxide, carbon dioxide), energy and water consumption and transport incidents, thereby showing a direct impact of the chemical industry on sustainable development."[75]

[81] Japan Chemical Industry Association: Responsible Care Report 2012.
http://www.nikkakyo.org/organizations/jrcc/report_e/2012/2012en.pdf

[82] https://responsiblecare.americanchemistry.com/ResponsibleCare/Performance-Results/Accountability-2/

As far as sustainable chemistry is concerned, it has tobe discussed whether the metrics selected are sufficient as they reflect only the operational performance (Health & Safety, Environment, Distribution) of the sector and its resource consumption and efficiency (Resources). Other aspects such as the chemical industry's contribution to the SDGs (e.g. SDG 12 Ensure sustainable consumption and production patterns) are addressed by a parameter (CO_2 intensity in Millions of Metric Tonnes Emitted per Millions of Metric Tonnes of Production) that does not take into account the impact of the raw materials used (e.g. unsustainable production and use of renewable resources, loss of biodiversity). Such aspects are only occasionally reported by individual federations (see example of JCIA[81] report on biodiversity).

Table 22: Evaluation of the Responsible Care® approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	There is no (autonomous) definition of sustainable chemistry. "ICCA did not explicitly define the term "sustainable chemistry", but is developing principles on SC. In the revised Responsible Care Global Charter one key element on Sustainability was added. However, it should be noted that RC does not claim to be industry's stand-alone answer to sustainability challenges, but that it clearly contributes to sustainable production and development and can be considered as foundation for sustainability."[75]
Consistency of indicator concept and how it is monitored	The indicator concept is oriented towards operational excellence, "including conservation of resources, reduction of emissions/water demand, improved communication within supply chain, provision of safety-relevant data as well as improved working conditions and less incidents."[75] But this is only one sustainable chemistry aspect: Responsible Care standards (sound management of chemicals and wastes) are minimum. Country reports are not available for all countries/federations.
Role of SDGs in the concept	MDGs or SDGs are not explicitly mentioned in the RC Status Report 2015[74]. "RC was developed to improve industry's health, safety, environment and security performance, which form the solid foundation of sustainability. However, it was not developed to respond to the MDGs or SDGs." [75] The European chemical industry's contribution to SDGs is published by CEFIC.[83] Responsible Care (in terms of "sound management of chemicals and wastes") is a prerequisite for reaching the SDGs.
Probability of implementation	Broadly implemented.
Overall impression	The aspiration of Responsible Care to monitor and communicate chemical industry achievements at the global level is met. For benchmarking, the metrics broken down by country, subsector and company should be published, see e.g. American Chemistry Council's (ACC) tool to compare member companies' individual performance online.[82] ICCA points out: "ICCA is a global association and therefore not in the position to publish data on local level, which is in the discretion of the local associations."[75] Though important aspects of sustainable chemistry (e.g. environmental (CO_2 emission) and social (transport incidents, fatalities) are considered, other relevant aspects of sustainable chemistry are not addressed globally

[83] http://www.cefic.org/sustainability/UN-Sustainable-Goals/

Subject	Comment
	(e.g. unsustainable production and use of renewable resources, loss of biodiversity), but only occasionally by individual associations. Here, ICCA points out: "RC was not developed as industry's sustainability initiative, but through its different elements considers sustainability and contributes to sustainable development."[75]

Source: Own compilation

6.2 World Business Council for Sustainable Development (WBCSD)

6.2.1 Characterization

"WBCSD is a global, CEO-led organization of over 200 leading businesses and partners working together to accelerate the transition to a sustainable world. We help make our member companies more successful and sustainable by focusing on the maximum positive impact for shareholders, the environment and societies. Our member companies come from all business sectors and all major economies, representing a combined revenue of more than US$8.5 trillion and with 19 million employees. Our Global Network of almost 70 national business councils gives our members unparalleled reach across the globe. WBCSD is uniquely positioned to work with member companies along and across value chains to deliver high-impact business solutions to the most challenging sustainability issues."[84]

"Founder" of the WBCSD is Stephan Schmidheiny, a Swiss business entrepreneur (Eternit; Brown, Boveri & Cie (BBC) (= today's ABB group)), who ended the use of asbestos at Eternit in 1986, almost 20 years before the 2005 EU-wide asbestos ban. In 1990 he was appointed chief adviser for business and industry to the secretary general of the Rio de Janeiro Earth Summit of 1992 (UNCED, United Nations Conference on Environment and Development). He then created the "Business Council for Sustainable Development" (BCSD), a forum in which leading business people from all over the world started working on a business perspective on environmental and development challenges. In 1995, BCSD and the World Industry Council for the Environment merged into the "World Business Council for Sustainable Development". The WBCSD is based in Geneva, Switzerland, with offices in New York ("North-America") and New Delhi (India).

"Membership of the World Business Council for Sustainable Development (WBCSD) is by invitation of the CEO of WBCSD, and approved by the Executive Committee, comprising up to 18 member-company CEOs. We welcome expressions of interest in membership from companies with a commitment to sustainable development, since the WBCSD's capacity to influence the broader debate is dependent on members who can enhance our work. Members of the WBCSD should be committed to the mission of the WBCSD … and to the objectives of the WBCSD which are to:

- be a business thought leader and advocate for sustainable development,
- participate in policy development to create the right framework conditions for business to make an effective contribution towards sustainable development,
- develop and promote the business case for sustainable development,
- develop scalable business solutions, and promote their implementation, for sustainable development,
- demonstrate and measure the business contribution to sustainable development and share leading edge practices among members,
- contribute to a sustainable future for all nations."[85]

[84] http://www.wbcsd.org/Overview/About-us

[85] WBCSD: WBCSD Membership Conditions 2017. http://www.wbcsd.org/contentwbc/download/1886/23998

Further conditions of membership include

- Be represented on the Council of the WBCSD by the Chief Executive Officer or board-level representative with overall responsibility for sustainable development;
- Publish a sustainability report annually (stand-alone, integrated or combined);
- Agree to have its sustainability report reviewed and benchmarked by WBCSD via a confidential process using transparent and objective criteria;[85]

Of the more than 200 members, 9 % belong to the chemical industry, followed by forests, paper & packaging (8 %), utilities & power, cement, oil & gas, and engineering (7 % each). 48 % of the members are located in Europe, 19 % in North America, 14 % in Asia (non-Japan), 9 % in Japan, 7 % in Latin America, 2 % in Africa and 1 % in Middle East.[86]

"Member companies are represented on the **Council** by the CEO or a board level executive. Council Members drive the strategic direction of the WBCSD and of individual projects where they can join or lead Cluster boards. This Council delegates the management of the organization to the **Executive Committee**. Members of the Executive Committee, including the Chairman and three Vice Chairmen, are elected for a two-year period by the Council. Responsibility for the day-to-day management of WBCSD affairs lies with the **President** based at the Geneva headquarters and assisted by a staff secretariat. Council Members are supported by a **Liaison Delegate**, usually a senior vice president or similar and typically global head of sustainability. … The **Council meets annually** to decide on the organization's priorities and discuss strategic issues connected to sustainable development."[87]

In spring 2010, the WBCSD presented its vision 2050[88], a far-reaching sustainability vision for business, highlighting the future prospects for those companies which make solutions for climate change, resource protection and elimination of social injustice their core business. "Companies with a strategic plan for sustainability will be better prepared for the challenges ahead and better able to seize the opportunities – to do less with more, to create value, to prosper and to advance the human condition."[89]

"In 2012, we adopted the Stockholm Resilience Center's planetary boundaries framework to define nine key priority areas necessary for reaching Vision 2050. Each focus area is built around specific social and environment targets that must be achieved in the transition to a sustainable world. These targets, or 'must haves', form the strategic focus of WBCSD's working group clusters and of Action2020. (Social Impact, Sustainable Lifestyles, Climate and Energy, Water, Ecosystems and Landscape Management, and Safe and Sustainable Materials). Each cluster serves as a dynamic space for WBCSD members and employees to connect, research, develop and implement the solutions needed for a sustainable world. Members work together in or across various clusters to coordinate, exchange ideas and uncover important sustainability solutions for business, society and the environment."[90]

Table 23 provides a short description of the WBCSD. Information was mainly sourced from the WBCSD website.[91]

[86] http://www.wbcsd.org/Overview/Our-members

[87] http://old.wbcsd.org/about/organization.aspx

[88] WBCSD: Vision 2050. The new agenda for business. 2010 http://www.wbcsd.org/contentwbc/download/1746/21728

[89] Sara Flores Carreño, Tamar Harel, Carmelina Macario: A Road map for Vision 2050. An implementation guide for executing the Vision 2050 report. July 2011 http://www.wbcsd.org/contentwbc/download/1766/22050

[90] http://www.wbcsd.org/Overview/About-us/Action2020

[91] http://www.wbcsd.org

Table 23: World Business Council for Sustainable Development (WBCSD): Short Characterization

Subject	Information
Name	World Business Council for Sustainable Development
(Main) URL	http://www.wbcsd.org/
Type of organization	Networking organization, "a CEO-led organization of forward-thinking companies", with a Global Network of almost 70 national business councils
Coverage/region	global
Institution(s) behind initiative/approach	>200 member companies
Legal information	Organization
Governance bodies	WBCSD Annual General Meeting (AGM) Executive Committee (2017: 15 members, of the 1 female)
President/CEO/Chairman	Peter Bakker, President and CEO, former CEO of TNT NV, the Netherlands-based holding company of TNT Express and Royal TNT Post Peter White, Vice President and COO, former Director for Global Sustainability at Procter & Gamble, and Chair of P&G's Sustainability Leadership Council
Year of foundation	1992 BCSD 1995 WBCSD
Budget/funding	Membership fees, member project fees, external funding
Links/closeness to other stakeholders	"The **Global Footprint Network** was our main research partner on the Vision 2050 report and is a participant in our measurement work."[92] "Since 2015, select universities, think tanks and foundations are eligible to join the WBCSD as Knowledge Partners, which is central to designing and scaling up business solutions. Yale University joined WBCSD as the first Knowledge Partner in 2015, and in 2016 we welcomed Arizona State University."[86]
Target audience and sectoral/geographical scope	Members, other stakeholders; global "We create a sense of urgency and create momentum by **being the leading business voice** making the case for action."[93]
Self-declared goal	"Our mission is to accelerate the transition to a sustainable world by making more sustainable businesses more successful." "Our vision is to create a world where more than 9 billion people are all living well and within the boundaries of our planet, by 2050."
Definition of sustainable chemistry resp. sustainability	No definition of sustainable chemistry or of sustainability "**Sustainability risk** is any risk or opportunity that could be categorized into the following areas: economic, product responsibility, supply chain practices, society, human rights, labor practices and decent work, ecosystem services, renewable resource use, non-renewable resource use, climate change, waste and effluents, and governance."[94]

[92] http://www.wbcsd.org/Clusters/Sustainable-Lifestyles/Partners

[93] http://careers.wbcsd.org/values/

[94] WBCSD: Sustainability and enterprise risk management:The first step towards integration, January 2017 http://www.wbcsd.org/contentwbc/download/2548/31131

Subject	Information
Concept of selected indicators	► Environmental: Chemical product footprint based on the ISO 14040:2006 and 14044:2006 as much as feasible; cradle-to-grave; eight mandatory environmental impact categories, further recommended[95] ► Social Life Cycle Metrics for Chemical Products: 25 topics/key impacts that might be generated by a chemical product during its life cycle regarding three key stakeholders (workers, local communities, consumers) among five social areas (basic rights and needs, employment, health & safety, skills & knowledge, well-being); cradle-to-gate and cradle-to-grave; a minimum set of eleven mandatory social topics should be assessed.[96]
Launch year, change in concept (if any) since then	2014 (Environmental) 2016 (Social)
Proposed instruments and measures for implementation	LCA reports
Status of implementation (e.g. description of best practice, etc.)	Environmental: Two case studies published[95]: ► Akulon fuel lock lined type 4 compressed natural gas tanks compared to metal or high-density polyethylene (HDPE) lined tanks, ► Heat sink made from a polymer compound with an aluminium insert compared to a heat sink made from die cast aluminium Social: One case study published[96]: ► Water delivering system in Europe, using PVC pipes
Status and type of monitoring including e.g. time series of indicator measurements	n.a.
Stakeholder dialogue	Global Network partners "reach approximately 5000 local companies, and a large number of governmental and non-governmental organizations".[97] Several events and workshops[97]
Additional information	GRI, UN Global Compact and WBCSD together offer the SDG compass. Its objective is to support companies in aligning their strategies with the SDGs and in measuring and managing their contribution. www.sdgcompass.org

Own compilation, sourcing the WBCSD website http://www.wbcsd.org/

[95] WBCSD: Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the environmental footprint of products, based on life cycle assessment. 2014
http://www.wbcsd.org/contentwbc/download/1886/23998

[96] WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016
http://www.wbcsd.org/contentwbc/download/1918/24428

[97] WBCSD: Global Network – 2016 snapshot of key activities and contributions to WBCSD work program.
http://www.wbcsd.org/contentwbc/download/2531/30983

The 2030 Agenda, the SDGs and the WBCSD

"The Sustainable Development Goals (SDGs) represent a comprehensive and detailed development agenda spanning social, environmental, and economic spheres; an agenda that has a resounding relevance for all stakeholders and all geographies. …

Although fundamentally it will be down to governments to tackle SDG implementation at a national level, the goals simply will not be achieved without meaningful action by business. Business has a key role to play as an engine of economic growth and employment and a source of finance, technology and innovation.

At the same time the SDGs also represent an historic opportunity for business. Companies can use the SDGs as an overarching framework to shape, steer, communicate and report their strategies, goals and activities, allowing them to capitalize on a range of benefits. **Those companies that embrace the transformative power of the goals will be able to open up exciting and lucrative new markets** while also contributing to the realization of stable societies and markets – the pillars upon which business success is built.

While pursuing these opportunities it is also important to remain mindful of the core responsibilities that business has with regard to the development agenda. The baseline for any company should be to ensure that its operations are not hindering global development. Negative social impacts, in particular around human rights, cannot be offset by positive contributions, and every company has a responsibility first and foremost to identify and mitigate them as a baseline for meaningful SDG alignment."

Source: http://sdghub.com/wbcsd-the-sdgs/

6.2.2 Criteria

Within its Chemical Sector Project "Reaching Full Potential", WBCSD has already published four guiding documents, the latest in 2016:

- Guidance for Accounting & Reporting Corporate GHG Emissions in the Chemical Sector Value Chain, 2013 [98]
- Addressing the Avoided Emissions Challenge, 2013 [99]
- Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the environmental footprint of products, based on life cycle assessment, 2014 [100]
- Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach, 2016 [101]

The guidance on Social Life Cycle Metrics for Chemical Products "was developed by the Reaching Full Potential chemical sector project and chaired by BASF, DSM and Solvay. Nine chemical companies collaborated to develop this guidance: AkzoNobel, BASF, DSM, Eastman Chemical, Evonik Industries, Henkel, Mitsubishi Chemicals Holdings Corporation, Sabic and Solvay. The group also included participation by the European Chemical Industry Council – Cefic, and was supported by PwC. Various value chain partners, NGOs and academia were involved in reviewing and improving the guidance throughout the process." [96]

[98] http://cebds.org/wp-content/uploads/2014/02/Guidance-for-Accounting-Reporting-Corporate-GHG-Emissions-in-the-Chemical-Sector-Value-Chain-Jan-20131.pdf

[99] ICCA/WBCSD: Guidelines from the chemical industry for accounting for and reporting greenhouse gas (GHG) emissions avoided along the value chain based on comparative studies. October 2013 http://wbcsdservers.org/wbcsdpublications/cd_files/datas/business-solutions/reaching-full-potential/pdf/E1%20CC%20LG%20guidance%20V3.pdf

[100] http://www.wbcsd.org/contentwbc/download/1886/23998

[101] http://www.wbcsd.org/Projects/Chemicals/News/New-WBCSD-guidance-supports-chemical-companies-to-assess-the-social-impact-of-their-products

These consist of 25 topics/key impacts that might be generated by a chemical product during its life cycle regarding three key stakeholders among five social areas. „Within the framework of social areas and stakeholders, 25 social topics were selected, among a total of 70, as the most representative for each combination of stakeholder and social area." [96]

"Theoretically, each product application could be assessed regarding the 25 social topics. Nevertheless, they are not always material with regard to the goal of the assessment and social issues of the chemical product for a given usage. In addition, the assessment of a product for each of the 25 social topics would increase the complexity and the time and resources allocated to the assessment, which would make the exercise unfeasible in a business context.

As the selection of social topics shall reflect a comprehensive set of social issues related to the product system being studied, this guide recommends a minimum set of social topics that should be covered. Therefore, in order to reduce the workload of product application social impact assessment, as well as to ensure, in the future, a minimum of comparability between assessments, the WBCSD working group has selected the following list of 11 mandatory social topics for any product application assessment carried out according to the present guide." [96]

Table 24 gives a survey on the 11 mandatory and 14 non mandatory social topics for assessing the social life cycle metrics for chemical products. Seven mandatory topics are concerning workers, three local communities and one consumers.

Table 24: WBCSD: The 11 mandatory (M) and 14 non mandatory (NM) social topics

Overarching social topics	Stakeholders		
	Workers	Local communities	Consumers
Bacis rights & needs	► **M: Fair wages** ► **M: Freedom of association, collective bargaining and labor relations** ► **M: No child labor** ► **M: No forced labor, human trafficking and slavery** ► *NM: Appropriate working hours* ► *NM: No discrimination* ► *NM: Social/employer security and benefits*	► **M: Access to basic needs for human rights and dignity (healthcare, clean water & sanitation, healthy food, shelter)** ► *NM: Respect for indigenous rights*	► *NM: Direct impact on basic needs (healthcare, clean water, healthy food, shelter, education)*
Employment	► *NM: Management of reorganization*	► **M: Job creation**	-
Health & Safety	► **M: Workers' occupational health risks** ► **M: Safety management system for workers** ► *NM: Management of workers' individual health*	► **M: Health and safety of local community's living conditions**	► **M: Impact on consumer health and safety**
Skills & Knowledge	► **M: Skills, knowledge and employability**	► *NM: Promotion of skills and knowledge*	► *NM: Promotion of skills and knowledge*

Overarching social topics	Stakeholders		
	Workers	Local communities	Consumers
Well-Being	► *NM: Job satisfaction*	► *NM: Access to basic needs for sustainable development (infra-structure, ICT, mod-ern energy)* ► *NM: Nuisance reduc-tion* ► *NM: Developing rela-tionship with local communities*	► *NM: Consumer's product experience*

Own compilation, based on WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

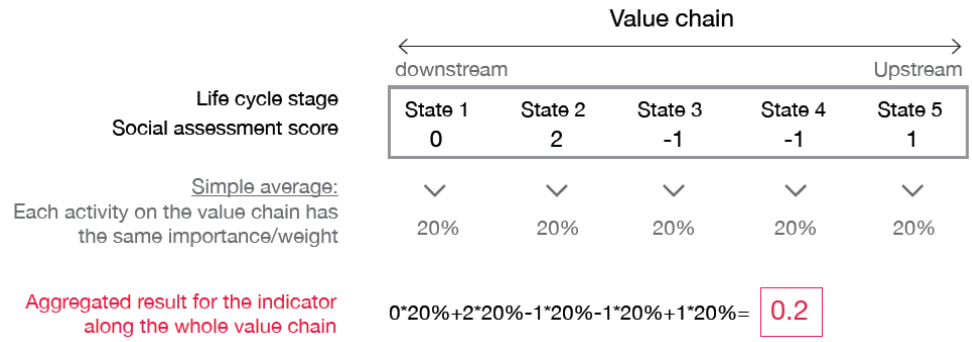
"11 mandatory social topics are to be covered **as a minimum** in every product assessment. Indicators and optional advanced indicators are proposed for each mandatory social topic. 14 non-mandatory social topics may be included in a product assessment based on a selection process defined in the present guide. Additional indicators and optional advanced indicators are also proposed for each non-mandatory social topic."[96]

"The social impact assessment of a product application … should cover the whole life cycle, down to the use and end-of-life of the product. The value chain will always (excepting for specific cases) cover the value chain from cradle-to-grave." [96]

„The indicators will enable the valuation of each social topic with the help of a scale that assesses each process or input linked to the functional unit of the product application from -2 to +2. ... The scales defined for each indicator ... were built on a chemical industry perspective, **with zero or medium performance indicating the industry's benchmark.**"

All actors along the value chain (in all involved countries) are assessed on the indicator for each social topic: „These values should be aggregated along the life cycle stages with a simple average. The worst cases (-2) shall still be flagged in addition to the aggregated result." [96]

Figure 3: WBCSD: Social Life Cycle Metrics for Chemical Products: Aggregation along the value chain



"Note: Simple average is used here as an illustration because it is the most straightforward."
Source: WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

Table 25: WBCSD: Indicators for the social topic "No child labor" (Mandatory)

Subject	Comment
Stakeholder Group	Workers
Social Topic Name	No child labor (Mandatory)
Explanation	"Child labor is work that deprives children of their childhood, their potential and their dignity, that is socially or morally dangerous and that is harmful to physical and mental development. In its most extreme forms, child labor involves children being enslaved, separated from their families, exposed to serious hazards and illnesses and/or left to fend for themselves on the streets of large cities. Child working constitutes child labor if the child is below: ► The age of 15 years; ► Or the minimum age for employment set in the country if it is higher; ► Or the age of completion of compulsory education if it is higher. However, if local minimum age law is set at 14 years of age in accordance with the developing country exception under ILO Convention 138, this lower age may apply. A young worker is any worker over the age of a child and under the age of 18. Young workers are allowed to work under the conditions stated in ILO Convention 138. (Based on ILO, UNEP/SETAC, Roundtable and NGOs (e.g. HIVOS))
Indicator	a) Policies against child labor, a compliance management process and proactive programs to actively engage in banning child labor exist. b) Proof of age records are documented. c) Employment, recruitment agencies and suppliers are proactively monitored to avoid child labor. d) Company provides access to remedy. e) Suppliers are actively encouraged to have policies against child labor, a compliance management process, and proactive programs to engage in banning child labor and to support school education. f) Suppliers are actively encouraged to provide access to remedy.
Advanced indicator 1	Child labor in the value chain Companies are increasingly concerned with child labor in their supply chains. They view it as inconsistent with company values and as a threat to their image and ability to recruit and retain top workers, as well as to the sustainability of their supply chain. Child laborers can be found in all stages of supply chains.

Own compilation, based on WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

Table 25 shows the indicators (regular and advanced) for the mandatory social topic „No child labor" (stakeholder group: workers), Table 26 the scales for both indicators. Following these tables, benchmark in the chemical industry is:

- Policies against child labor, a compliance management process and proactive programs to actively engage in banning child labor exist. AND
- Proof of age records are documented. AND
- Employment, recruitment agencies and suppliers are proactively monitored to avoid child labor. AND
- Company provides access to remedy. AND
- Advanced indicator: Not a single case of child labor in the reporting company can be detected.

Table 26: WBCSD: Reference scale and application on the mandatory indicator "No child labor"

Scale	Generic reference	Indicator	Advanced indicator 1
2	Outstanding/ Exemplary performance	a, b, c, d, e, f achieved	Not a single case of child labor in the value chain companies can be detected and child labor is monitored/targeted in the key life cycle stages of the value chain companies.
1	Good performance	a, b, c, d, e achieved	Not a single case of child labor in the reporting company can be detected and child labor is monitored/targeted in some of the value chain companies.
0	Standard performance/ compliance	a, b, c, d achieved	Not a single case of child labor in the reporting company can be detected.
-1	Inadequate performance	a achieved	Child labor in the value chain companies can be detected. Kind of child labor is described. Actions are undertaken to reduce child labor (e.g. support of children's school education) and positive results are measured.
-2	Unacceptable performance	a, b, c, d, e, f not achieved	Child labor in the value chain companies can be detected. Kind of child labor is not described. Measurable results describing the reduction of child labor or other achieved improvements (e.g. support of children's school education) do not exist.

Own compilation, based on WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

Table 27 shows the indicators (regular and three advanced) for the mandatory social topic „Access to basic needs for the human right to dignity" (stakeholder group: local community), Table 28 the scales for the indicators. Following these tables, benchmark in the chemical industry is:

- The company or facility is taking action to improve the situation when harm is done by the company to the local community's access to basic needs for the human right to dignity. AND
- The company or facility can demonstrate that it does no harm to the local community's access to basic needs for the human right to dignity (e.g. by having carried out an impact assessment). AND
- Advanced indicator 1: At least 95 % of the community has access to adequate healthcare services. OR
- Advanced indicator 2: Company or facility can demonstrate that it does no harm (but also does not contribute) to the local community's access to shelter. OR
- Advanced indicator 3: Company or facility can demonstrate that it does no harm (but also does not contribute) to the local community's access to education.

Table 27: WBCSD: Indicators for the social topic "Access to basic needs for the human right to dignity" (Mandatory)

Subject	Comment
Stakeholder Group	Local community
Social Topic Name	Access to basic needs for the human right to dignity (Mandatory)
Explanation	The extent to which a contribution is made to access to: ► Healthcare (e.g. health camps with doctors for health checks, medicine). It includes prevention and curing. If the company is harming access to healthcare, this leads to negative scores. ► Clean water or sanitation. If the company is deteriorating clean water, polluting water and does not clean or is destroying access to clean water or services to provide sanitation, this leads to negative scores. ► Healthy food. If (risk of) competition with existing services to provide healthy food is identified, this will lead to negative scores. If the company is deteriorating or wasting food and does not do anything to compensate, this leads to negative scores. ► Shelter. If the company is deteriorating or destroying houses and does not do anything to compensate local communities, this leads to negative scores. ► Education. The extent to which the company provides the community with educational programs and, thereby, increases educational levels, improves learning and earning capabilities, and raises economic development. Educational programs in developing countries can target essential education and literacy and access to higher education in developed countries. (Based on ILO, UNEP/SETAC and Roundtable definitions)
Indicator	a) The company or facility is taking action to improve the situation when harm is done by the company to the local community's access to basic needs for the human right to dignity b) Company or facility can demonstrate that it does no harm to the local community's access to basic needs for the human right to dignity (e.g. by having carried out an impact assessment). c) Policies and first initiatives are in place to improve local community's access to basic needs for the human right to dignity. d) Company or facility provides local community with specific services. e) Measurable improvement in health/living/education conditions of local community is being tracked. f) Company or facility provides a grievance mechanism or other feedback loop for the local community.
Advanced indicator 1	Local community's access to adequate healthcare services and company's contribution to healthcare services.
Advanced indicator 2	Local community's access to shelter: Decreased # of homeless people
Advanced indicator 3	Local community's access to education: Literacy levels # people with primary level education

Own compilation, based on WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

Table 28: WBCSD: Reference scale and application on the mandatory indicator "Access to basic needs for the human right to dignity"

Scale	Generic reference	Indicator	Advanced indicator 1
2	Outstanding/ Exemplary performance	a, b, c, d, e, f achieved	Level 0 AND The company contributes to 0.2 % of their revenue for healthcare services. Alternative: Government invests 2% of the tax income in healthcare services.
1	Good performance	a, b, c achieved	Level 0 AND The company contributes to 0.1 % of their revenue for healthcare services. Alternative: Government invests 1% of the tax income in healthcare services.
0	Standard performance/ compliance	a, b achieved	At least 95 % of the community has access to adequate healthcare services.
-1	Inadequate performance	a partially achieved	At least 75 % of the community has access to adequate healthcare services.
-2	Unacceptable performance	a, b, c, d, e, f not achieved	At least 50 % of the community has access to adequate healthcare services.

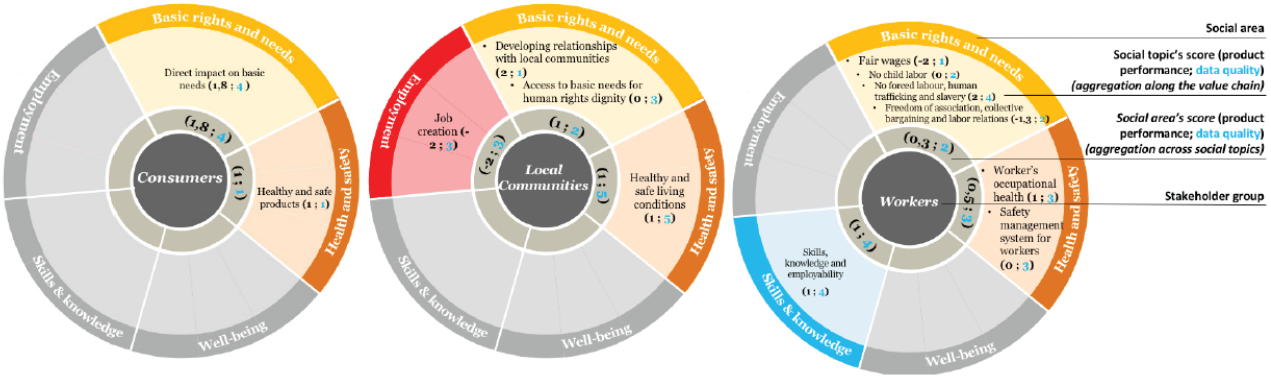
Table 28: WBCSD: Reference scale and application on the mandatory indicator "Access to basic needs for the human right to dignity", continued

Scale	Generic reference	Advanced indicator 2	Advanced indicator 3
2	Outstanding/ Exemplary performance	Decreased # of homeless people.	Improved literacy levels. Increased # people with primary level education.
1	Good performance	No measurable progress in the number of homeless people yet made despite considerable efforts (resources, time, money) invested.	No measurable progress yet made despite considerable efforts (resources, time, money) invested.
0	Standard performance/ compliance	Company or facility can demonstrate that it does no harm (but also does not contribute) to the local community's access to shelter.	Company or facility can demonstrate that it does no harm (but also does not contribute) to the local community's access to education.
-1	Inadequate performance	Company or facility cannot demonstrate that it does no harm to the local community's access to shelter.	Company or facility cannot demonstrate that it does no harm to the local community's access to education.
-2	Unacceptable performance	Increased # of homeless people. Company prevents community from getting access to shelter and/or competes with local public housing services/ facilities. For example, company/ facility destroys housing, forces people to relocate without compensation.	Deterioration of literacy level or reduced # of people with primary level education. Company prevents community from getting access to education and/or competes with local schools. For example, company/facility prevents children from going to school.

Own compilation, based on WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

For a quick view of the key results results of the assessment it is proposed to present them using one graph for each stakeholder category, differentiated according to each mandatory and additional social topic selected. In the exemplary graph below, „the widths of the social topics do not reflect their importance; they are only due to the fact that some social areas contain more social topics than others." [96]

Figure 4: Example of presentation of aggregated results



Source: WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

The guideline includes the application example of PVC pipes for water delivery in Europe. The results of this example are shown in detail in

Table 29. The authors give the following interpretation of the results:

„Step-based aggregation

Among all life cycle steps studied, oil extraction is the step with the worst marks, in particular regarding basic rights and needs, human rights violation, living conditions, workers' occupational health. Results are negatively impacted by the poor situation in Venezuela, where 60 % of the crude oil used to produce PVC pipes comes from. Pipe manufacturing, that takes place in Spain, is the steps with the second worst marks, especially regarding basic rights and needs (fair wages, child labour, forced labour), due to the absence of annual report and information regarding compensation management system or salary structure.

Refining of naphta and production of ethylene, vinyl chlorine and PVC are the two steps with the best marks. Company producing these intermediary products and products are located in Europe. They are especially outstanding performers regarding access of local communities to basic needs for human rights dignity, absence of forced labour, human trafficking and slavery, job creation and developing relationship with local communities. European companies producing ethylene, vinyl chlorine and PVC are also best in class for providing fair wages to workers and direct impact to basic needs for consumers.

Value-chain aggregation

Among all social topics, the PVC pipes record the best marks for job creation (however, for three steps the assessment is not available for this social topic due to data availability) and the development of relationship with local communities.

The PVC pipes record the worst marks for the impact on consumers' health and safety and no forced labour, human trafficking and slavery social topics.

The PVC pipes did not get an aggregated negative score for any of the social topics studied. So we can conclude that in general, the PVC pipes manufactured in Europe and installed in France have very limited negative impacts on the three stakeholder groups studied (workers, consumers, local communities).

Table 29: WBCSD: Results of the application example „PVC pipes for water delivery in Europe“

				Upstream		Own operations
			Key lifecycle stages	Oil extraction	Refining of naphta	Chlorine, Ethylene, VC and PVC Manufacturing
			Source of information	Tier 2	Tier 1	Own sites
			Operating country	North SEA (40%) Venezuela (60%)	Europe	Europe
Social area	**Stakeholder group**	**13 mandatory and additionnal social topics**		**Upstream**		**Own operations**
Basic rights and needs	Local communities	Access to basic needs for human right dignity (healthcare, clean water & sanitation, healthy food, shelter)	**Result**	0	2	2
			Data quality	4	3	4
	Consumers	Direct impact on basic needs (healthcare, clean water, healthy food, shelter, education)	**Result**	1	1	2
			Data quality	5	5	5
	Workers	Fair wages	**Result**	-1	1	2
			Data quality	3	2	1
		No child labour	**Result**	-1	1	1
			Data quality	3	2	2
		Freedom of association, collective bargaining and labor relations	**Result**	0	2	2
			Data quality	2	2	1
		No forced labour, human trafficking and slavery	**Result**	-1	2	2
			Data quality	3	2	2
Health and safety	Local communities	Health and safety of local communities living conditions	**Result**	-1	1	1
			Data quality	2	3	2
	Consumers	Impact on consumers health and safety	**Result**	0	0	0
			Data quality	4	4	4
	Workers	Safety management system for workers	**Result**	-1	2	2
			Data quality	3	1	1
		Workers' occupational health risks	**Result**	-1	2	2
			Data quality	3	1	1
Employment	Local communities	Job creation	**Result**	1	2	2
			Data quality	3	2	2
Skills and knowledge	Workers	Skills, knowledge and employability	**Result**	2	1	1
			Data quality	3	2	2
Well-being	Local communities	Developing relationship with local communities	**Result**	2	2	2
			Data quality	3	2	2
		Step-based aggregation	**Performance**	**0.0**	**1.5**	**1.6**
			Data quality	**3.1**	**2.4**	**2.2**

Performance:	**Data quality:**
2 (≥1,5)	**1 (≤1,5)**
1 (≥0,5 ; <1,5)	**2 (>1,5 ; ≤2,5)**
0 (≥-0,5 ; <0,5)	**3 (>2,5 ; ≤3,5)**
-1 (≥-1,5 ; <-0,5)	**4 (>3,5 ; ≤4,5)**
-2 (<1,5)	**5 (>4,5)**

Source: WBCSD: Social Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the social impact of chemical products, based on a life cycle approach. November 2016 http://www.wbcsd.org/contentwbc/download/1918/24428

Table 29: WBCSD: Results of the application example „PVC pipes for water delivery in Europe“, cont.

				Downstream		Use phase
			Key lifecycle stages	Pipes manufacturing	Pipe installation	Use phase (product maintenance only)
			Source of information	Customers	Installation	Clients
			Operating country	Spain	France	France
Social area	**Stakeholder group**	**13 mandatory and additionnal social topics**		**Downstream**		**Use phase**
Basic rights and needs	Local communities	Access to basic needs for human right dignity (health-care, clean water & sanitation, healthy food, shelter)	**Result**	0	1	1
			Data quality	4	5	3
	Consumers	Direct impact on basic needs (healthcare, clean water, healthy food, shelter, education)	**Result**	2	not applicable	not applicable
			Data quality	3	not applicable	not applicable
	Workers	Fair wages	**Result**	-1	1	1
			Data quality	2	2	2
		No child labour	**Result**	-1	1	1
			Data quality	2	2	2
		Freedom of association, collective bargaining and labor relations	**Result**	2	1	2
			Data quality	3	1	2
		No forced labour, human trafficking and slavery	**Result**	-1	-1	0
			Data quality	2	2	2
Health and safety	Local communities	Health and safety of local communities living conditions	**Result**	2	2	0
			Data quality	4	3	4
	Consumers	Impact on consumers health and safety	**Result**	0	0	0
			Data quality	4	4	4
	Workers	Safety management system for workers	**Result**	0	2	not applicable
			Data quality	2	2	not applicable
		Workers' occupational health risks	**Result**	2	1	not applicable
			Data quality	2	2	not applicable
Employment	Local communities	Job creation	**Result**	Unknown	Unknown	not applicable
			Data quality	5	5	not applicable
Skills and knowledge	Workers	Skills, knowledge and employability	**Result**	1	1	not applicable
			Data quality	2	2	not applicable
Well-being	Local communities	Developing relationship with local communities	**Result**	1	2	not applicable
			Data quality	2	2	not applicable
		Step-based aggregation	**Performance**	**0.6**	**1.0**	**0.7**
			Data quality	**2.8**	**2.7**	**2.7**

Performance:	**Data quality:**
2 (≥1,5)	**1 (≤1,5)**
1 (≥0,5 ; <1,5)	**2 (>1,5 ; ≤2,5)**
0 (≥-0,5 ; <0,5)	**3 (>2,5 ; ≤3,5)**
-1 (≥-1,5 ; <-0,5)	**4 (>3,5 ; ≤4,5)**
-2 (<1,5)	**5 (>4,5)**

Table 29: WBCSD: Results of the application example „PVC pipes for water delivery in Europe“, cont.

				End of life	
			Key lifecycle stages	PVC pipes waste management	
			Source of information	End of life	
			Operating country	France	Aggregation along the value chain
Social area	**Stakeholder group**	**13 mandatory and additionnal social topics**		**End of life**	**PERF.**	**DATA QUALITY**
Basic rights and needs	Local communities	Access to basic needs for human right dignity (health-care, clean water & sanitation, healthy food, shelter)	**Result**	1	**1.0**	**3.9**
			Data quality	5		
	Consumers	Direct impact on basic needs (healthcare, clean water, healthy food, shelter, education)	**Result**	not applicable	**1.5**	**2.6**
			Data quality	not applicable		
	Workers	Fair wages	**Result**	1	**0.6**	**2.3**
			Data quality	2		
		No child labour	**Result**	1	**0.4**	**2.5**
			Data quality	2		
		Freedom of association, collective bargaining and labor relations	**Result**	1	**1.4**	**2.0**
			Data quality	1		
		No forced labour, human trafficking and slavery	**Result**	-1	**0.0**	**2.5**
			Data quality	2		
Health and safety	Local communities	Health and safety of local communities living conditions	**Result**	0	**0.7**	**3.1**
			Data quality	4		
	Consumers	Impact on consumers health and safety	**Result**	0	**0.0**	**4.0**
			Data quality	4		
	Workers	Safety management system for workers	**Result**	2	**1.2**	**1.8**
			Data quality	2		
		Workers' occupational health risks	**Result**	1	**1.2**	**1.8**
			Data quality	2		
Employment	Local communities	Job creation	**Result**	Unknown	**1.7**	**3.7**
			Data quality	5		
Skills and knowledge	Workers	Skills, knowledge and employability	**Result**	1	**1.2**	**2.2**
			Data quality	2		
Well-being	Local communities	Developing relationship with local communities	**Result**	2	**1.8**	**2.2**
			Data quality	2		
		Step-based aggregation	**Performance**	**0.8**		
			Data quality	**2.8**		

Performance:	**Data quality:**
2 (≥1,5)	**1 (≤1,5)**
1 (≥0,5 ; <1,5)	**2 (>1,5 ; ≤2,5)**
0 (≥-0,5 ; <0,5)	**3 (>2,5 ; ≤3,5)**
-1 (≥-1,5 ; <-0,5)	**4 (>3,5 ; ≤4,5)**
-2 (<1,5)	**5 (>4,5)**

Data quality

The assessment was done mainly on the basis of public information (CSR Reports, Annual Reports, (Supplier) Code of Conduct, etc.) from key actors identified for each step of the value chain[102]. The social topics Access to basic needs for human right dignity and job creation record the worst data quality. Social topics on health and safety of workers (implementation of safety management systems, workers' occupational health) record the highest data quality." [96]

6.2.3 Evaluation

It was not possible to describe the methodology and the criteria and metrics (scaling) in detail within this report. As this is a very young approach (published in November 2016) there is only one case study available. But this approach (in addition to environmental LCA) looks very promising for assessing the social impact of chemicals or chemical products throughout their entire life cycle (cradle-to-grave). In particular, the inclusion of the entire value chain and the impact at local communities is an approach that is completely in line with the definition of sustainable chemistry.

Table 30: Evaluation of the WBCSD approach on social topics

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No definition of sustainable chemistry; understanding of sustainable development follows the triple bottom line approach.
Consistency of indicator concept and how it is monitored	Indicators are consistent to concept. Availability of data is somehow critical. Monitoring: no information.
Role of SDGs in the concept	"Negative social impacts, in particular around human rights, cannot be offset by positive contributions, and every company has a responsibility first and foremost to identify and mitigate them as a baseline for meaningful SDG alignment." (see box on page 72)
Probability of implementation	Very high, as WBCSD is a global driver, and leading companies were involved in the development
Overall impression	Frontrunner

Source: Own compilation

6.3 Together for Sustainability (TfS)

Georg Kell, Executive Director of the UN Global Compact, points out: "An increasing amount of companies have realized the crucial importance of incorporating sustainability requirements into their supply chain programme in order to secure their own brand value, manage legal, regulatory and reputational risks as well as foster product innovation and explore new markets. Moreover, businesses consider the many rewards supply chain sustainability can deliver in terms of creating more inclusive markets and the contribution they can make to advance sustainable development in the spirit of the United Nations' missions."[103]

[102] Corresponding to a data quality between 2 and 3, on a scale of 5 (1 corresponding to the highest data quality).

[103] United Nations Global Compact and BSR: Supply Chain Sustainability – A Practical Guide for Continuous Improvement, Second Edition, 2015. http://www.unglobalcompact.org/docs/issues_doc/supply_chain/SupplyChainRep_spread.pdf

6.3.1 Characterization

Together for Sustainability (TfS) was founded in 2011 by the chief procurement officers of six multinational chemical companies (BASF, Bayer, Evonik Industries, Henkel, LANXESS and Solvay). The purpose is to develop and implement a global audit programme to assess and improve sustainability practices within the supply chains of the chemical industry. TfS has the following objectives:[104]

- Join forces to create standards for sustainable supply chains
- Share sustainability assessments and audit results
- Raise awareness and initiate continuous improvements
- Exchange and promote best practices
- Use resources more efficiently and follow the principle of: "An audit for one is an audit for all".

As of November, TfS has 19 members. "Collectively, TfS Members represent € 180 billion in spend (based on published financial reports) and an estimated € 276 billion in turnover." [105]

To become a member, the company has to adhere to TfS criteria. Besides paying the fees (annual membership fee plus one-time joining and onboarding support fee, both based on company size), these are:

- UN Global Compact: Member or public supporter of the UN Global Compact
- Transparency: Sustainability report published regularly (GRI or integrated report)
- Sustainability ratings: EcoVadis score above 60
- Supplier assessments (based on company size): Minimum number of shared supplier assessments via EcoVadis per year
- Supplier audits (based on company size): Minimum number of shared TfS audits per year

"The initiative is based on good practices and builds on established principles – such as the United Nations Global Compact (UNGC) and the Responsible Care Global Charter as well as standards developed by the International Labor Organization (ILO), the International Organization for Standardization (ISO), Social Accountability International (SAI) and others."[106]

"The TfS initiative involves assessments and audits of suppliers by independent experts:

- **Assessments**: TfS selected EcoVadis[107], a Paris-based rating company in sustainable supply management, as its partner for supplier sustainability scorecards. Assessment results and scorecard ratings are shared within TfS on a web-based collaborative platform.
- **Audits**: TfS separately is working with independent audit firms to measure the supplier's sustainability performance against a pre-defined set of audit criteria tailored to the requirements of the chemical industry. They include management, environment, health & safety, labor & human rights, and governance topics. Audits comprise on-site examination covering, for example, production facilities, warehouses and office buildings." [106]

"Assessments are valid for three years but TfS members may ask suppliers to go through a more regular assessment to show continuous improvement. The frequency may also depend on the result of the assessment. The validity of an audit depends on the audit results. In case of no or minor findings the audit is valid for 36 months." [108]

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[104] http://tfs-initiative.com/sustainable-supply-chains/#1473840539214-f55f9dde-3a96

[105] TfS: Annual Activity Report 2015. http://www.tfs-initiative.com/dl/TfS_Annualactivityreport_2015.pdf

[106] TfS: More sustainability in the chemical supply chain. Press release, Duesseldorf, October 7, 2013 http://www.tfs-initiative.com/dl/20131007_TfS_Press_Release_More-sustainability-in-the-chemical-supply-chain_en.pdf

[107] http://www.ecovadis.com/

[108] http://tfs-initiative.com/sustainable-supply-chains/#1473855823354-304d7ede-e5c7

"It is an individual decision of each TfS member company whether to invite suppliers to an EcoVadis assessment, a TfS audit, or both."[109]

"The TfS program is neither a certification scheme nor a simple comply-or-fail exercise. On the contrary, it offers instruments for buyers and suppliers to assess sustainability performance and identify opportunities for improvement. As such, suppliers which do not meet all assessment or audit criteria are expected to set-up a corrective action plan (CAP) to document targets and improvements over time."[110]

"Since the start of the TfS initiative, the sustainability performance of 4,600 suppliers has been rated within the TfS initiative based on assessments and 446 TfS audits have been conducted by means of the TfS Audit Program. In 2015, 179 new TfS audit reports were received by the TfS initiative and a total of 2,580 sustainability assessments of suppliers were shared among TfS Members through the platform." [105]

Table 31 provides a short description of Together for Sustainability (TfS). Information was mainly sourced from TfS's website[111] and its Annual Activity Report 2015[105].

Table 31: Together for Sustainability (TfS): Short Characterization

Subject	Information
Name	Together for Sustainability aisbl (TfS)
(Main) URL	http://tfs-initiative.com
Type of organisation	Non-profit association
Coverage/region	International
Institution(s) behind initiative/approach	Founding members: BASF, Bayer, Evonik Industries, Henkel, LANXESS and Solvay; 19 members as of 11/2016
Legal information	International non-profit association under Belgian law (association internationale sans but lucratif – aisbl)
Governance bodies	General Assembly: TfS's highest decision-making body; composed of one Chief Procurement Officer (CPO) representing each of the member companies which hold voting rights in the Association. Steering Committee: Executive body of the Association, composed of seven different members, including the TfS President. The current Steering Committee was elected by the General Assembly in 2014.
President/CEO/Chairman	Ruediger Eberhard, President, Chief Procurement Officer, Evonik Industries General Manager: Dr. Gabriele Unger
Year of foundation	2011
Budget/funding	n.a. "TfS Work Streams: Each Work Stream is responsible for developing and managing different aspects of the TfS program, and is composed of staff from various member companies, making this a truly member-led initiative. Active participation from our members is crucial for the success of the initiative."

[109] http://tfs-initiative.com/sustainable-supply-chains/#1473854649529-2ff79fc1-652f

[110] http://tfs-initiative.com/sustainable-supply-chains/#1473854652402-52becbd8-9bd9

[111] http://tfs-initiative.com

Subject	Information
Links/closeness to other stakeholders	The TfS office opened at the CEFIC premises in Brussels in 2015. Others: VCI, Chemie[3], China Petroleum and Chemical Industry Federation (CPCIF)
Target audience and sectoral/geographical scope	Chemical industry and its suppliers; global
Self-declared goal	"The purpose is to develop and implement a global audit program to assess and improve sustainability practices within the supply chains of the chemical industry. TfS' long term goal is to become the standard for the chemical industry in terms of Supply Chain sustainability – any chemical company wishing to partner with TfS can embark on that journey as well."
Definition of sustainable chemistry resp. sustainability	No definition of sustainable chemistry. "Together for Sustainability supports and promotes the principles of the UN Global Compact and Responsible Care on sustainable development and continuous improvement."
Concept of selected indicators	"The initiative is based on good practices and builds on established principles – such as the United Nations Global Compact (UNGC) and the Responsible Care Global Charter as well as standards developed by the International Labor Organization (ILO), the International Organization for Standardization (ISO), Social Accountability International (SAI) and others." [106]
Launch year, change in concept (if any) since then	2013
Proposed instruments and measures for implementation	► Assessments: Conducted by using an online web-based questionnaire; documents will be requested as proof of implementation and reviewed, and data and information will be analyzed. ► Audits: On-site examination of a company's sustainability practices by an independent third-party auditor
Status of implementation (e.g. description of best practice, etc.)	Since 2011: ► 4,600 suppliers' sustainability performance assessed ► 446 audits conducted 2015: ► 179 new TfS audit reports received ► a total of 2,580 sustainability assessments of suppliers were shared among TfS Members through the platform
Status and type of monitoring including e.g. time series of indicator measurements	TfS audit reports and assessments are valid for 3 years. They are only disclosed to TfS members.
Stakeholder dialogue	"TfS is open to dialogue and cooperation with representatives from a range of organizations, in order to work jointly on improving sustainability in the chemical supply chain. As the focus of TfS is on the supply chains of the Chemical Industry, the International Council of Chemical Associations (ICCA) and the regional Chemical Associations – ACC for North America, CEFIC for Europe – as well as local Chemical Associations are important stakeholders."

Subject	Information
Additional information	TfS and EcoVadis extended their partnership in 2015 and established an Executive Council as a forum for regular exchange and the development of a joint Operational Roadmap.

Own compilation, using the following sources: TfS's website and TfS's Annual Activity Report 2015
http://tfs-initiative.com
http://www.tfs-initiative.com/dl/TfS_Annualactivityreport_2015.pdf

6.3.2 Criteria

The criteria for assessment by EcoVadis and TfS audit "are not identical but quite comparable. The four assessment areas are: environment, social, ethics, supply chain. The TfS audit criteria refer to five areas, including management, environment, health & safety, labor & human rights and governance. The main difference between EcoVadis assessments and TfS audits is that the EcoVadis assessment is based on document analysis and publicly available sources of information while TfS audits are based on on-site inspections by an independent auditor, interviews and document review."[112] Table 32 shows the criteria for TfS audits.

Table 32: Together for Sustainability (TfS): Standards to be met by suppliers

Audit area	Criteria
Management	► Management in charge, policies, continuous improvement, management systems, risk assessment training
Environment	► Environmental compliance, waste, air emissions, climate change, water and groundwater, wastewater, energy, nuisance (noise & odour), land use & biodiversity, soil, hazardous chemicals
Health & Safety	► Health & safety compliance, product safety, transport safety, process safety & storage, occupational health & safety, emergency preparedness, medical care, security, hygienic facilities
Labour & Human Rights	► Labour & human rights compliance, child labour, forced & compulsory labour, working hours, minimum wages, freedom of association, discrimination, special work contracts
Ethics & Governance	► Supplier standards, memberships, business integrity, privacy & intellectual property, fair completion, disciplinary & compliancy procedures

Own compilation, using the following source: TfS: Annual Activity Report 2015.
http://www.tfs-initiative.com/dl/TfS_Annualactivityreport_2015.pdf

Information about the indicators listed and the weighting of the various indicators is not publicly available.

6.3.3 Evaluation

Supply chain sustainability is an essential component of sustainable chemistry and is a "must-have" for companies which have signed the UN Global Compact. Therefore tools that help chemical companies to improve their performance and in parallel reduce their risks and costs are useful. Whether TfS is such a tool is a question that only the members can assess. In any case they will profit from the transparency they create with their sustainability reports (see self-commitment of TfS members).

[112] http://tfs-initiative.com/sustainable-supply-chains/#1473855463477-295be343-dd27

For the purpose of this study, the TfS approach to sustainability or to sustainable supply chains is of interest. Using the information available for non-members, the audit areas and criteria can be regarded as consistent with the concept. As the indicators are not available, no further evaluation can be made.

Table 33: Together for Sustainability (TfS): Evaluation

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No definition of sustainable chemistry. Sustainability approach follows environmental, social and governance (ESG) principles, in accordance with GRI.
Consistency of indicator concept and how it is monitored	Audit areas and criteria are consistent with the concept. Indicators are not available.
Role of SDGs in the concept	Not explicitly mentioned.
Probability of implementation	Implemented.
Overall impression	Probably a valuable tool for industry (cost saving, minimising reputation risk) on a voluntary basis. Transparency is ensured through regularly published sustainability reports of TfS members (GRI or integrated report, see self-commitment of members). Lack of transparency concerning indicators.

Source: Own compilation

6.4 Chemie^3, Germany

6.4.1 Characterization

In May 2013, Chemie^3 was launched by the German Chemical Industry Association (VCI), the Mining, Chemical and Energy Industrial Union (IG BCE) and the German Federation of Chemical Employers' Associations (BAVC). The aim is to underpin sustainability as a guiding principle of the chemical industry in Germany and to put the twelve "Sustainability Guidelines for the Chemical Industry in Germany" into business practice. They reflect core elements from national, European and international initiatives and standards, such as the 10 principles of the UN Global Compact, the Core Labour Standards of the International Labour Organisation (ILO), and the OECD Guidelines for Multinational Enterprises.

The twelve guidelines at a glance:

1. Integrating sustainability into the corporate strategy
2. Achieving sustainable investments and value creation
3. Promoting economic stability and global cooperation
4. Driving sustainability through innovation
5. Implementing sustainability in operational processes
6. Securing decent work and an active social partnership
7. Managing demographic change and securing skills
8. Protecting people, the environment and biodiversity
9. Promoting resource efficiency and climate protection

10. Engaging with communities as good citizens
11. Creating transparency and showing integrity
12. Fostering a dialogue and enhancing participation

Table 34 gives a short survey on Chemie³. The informations are mainly based on the Chemie³'s Report 2013[113] and its Progress Report 2015[114].

Table 34: Chemie³, Germany: Short characterization

Subject	Information
Name	**Chemie³**
(Main) URL	https://www.chemiehoch3.de/de/home.html
Type of organisation	Chemical industry initiative
Coverage/region	Germany
Institution(s) behind initiative/approach	German Chemical Industry Association (VCI) Mining, Chemical and Energy Industrial Union (IG BCE) German Federation of Chemical Employers' Associations (BAVC)
Legal information	**NO legal entity.** The initiators of Chemie³, the sustainability initiative of the German Chemistry, are VCI, IG BCE and BAVC. Operator of the website is the Chemiewirtschaft Promotion GmbH, Frankfurt, Email: stephan@vci.de. Registered office is Frankfurt am Main. Represented by the Managing Director Johann-Peter Nickel and Reinhart Stephan. Commercial Register HRB 6167, Tax ID No.: DE 114 132 656 I Responsible pursuant to § 55 paragraph 2 of the Law on Broadcasting and Telemedia is: Dr. Martina Ludwig, Email: ludwig@vci.de
Governance bodies	Coordinator: VCI
President/CEO/ Chairman	n.a.
Year of foundation	2013
Budget/funding	n.a.
Links/closeness to other stakeholders	European Chemical Industry Council Cefic, the European Chemical Employers Group ECEG, the International Council of Chemical Associations ICCA, the IndustriAll Global Union, the China Petroleum and Chemical Industry Federation CPCIF, the International Chamber of Commerce ICC, and the International Labour Organization ILO
Target audience and sectoral/geographical scope	Chemical industry in Germany / Europe
Self-declared goal	To further the cause of sustainability in the chemical industry by promoting sustainable business practices throughout the chemical industry (12 Guidelines)
Definition of sustainable chemistry resp. sustainability	**see Responsible Care, and:** The initiative considers all three dimensions of sustainability – economy, environment, and society: ► Economic success, which is the basis for developing the industry and our wealth.

[113] https://www.chemiehoch3.de/fileadmin/user_upload/downloads/CHEMIE3-NH-Publikation-EN.pdf

Subject	Information
	► Protection of people and the environment through environmentally acceptable products and processes, and also through high safety standards, product stewardship and smart efficiency and raw material strategies. ► Social responsibility, which in Germany is based on the social market economy and the strong social partnership within the chemical industry.
Concept of selected indicators	In 2015 the alliance partners **have started to identify appropriate indicators** and develop new ones if needed. This process should be completed in late 2016.
Launch year, change in concept (if any) since then	2013
Proposed instruments and measures for implementation	This commitment on the part of the chemical industry in Germany is demonstrated by its participation in the **Responsible Care initiative** and in its social partnership activities. The aim of the 12 "**Sustainability Guidelines for the chemical industry in Germany**" (2013) is to underpin sustainability as a guiding principle within the industry. The guidelines are are available in German, English and Chinese. In addition: Chemie³-Sustainability-Check: Only available for members
Status of implementation (e.g. description of best practice, etc.)	In 2015 the alliance partners **have started to identify appropriate indicators** and develop new ones if needed. This process should be completed in late 2016. A selection of economic, social and environmental parameters are shown in the Progress Report 2015, p. 20 3 Best Practice examples in the Progress Report 2015, p. 17/18
Status and type of monitoring including e.g. time series of indicator measurements	"Per an agreement with the German federal government, the economy including the chemical industry has committed to increasing energy efficiency by 1.3 percent, and starting in 2017 by 1.35 percent, each year and introducing energy management systems. This is the basis for claiming the maximum ecotax credit." (From Progress Report 2015, p. 13)
Stakeholder dialogue	In 2014, Chemie³ organized stakeholder events in Nauen and Berlin and established a platform to conduct an open and continuous dialogue with a permanent group of participants in its stakeholder round table.
Additional information	-

Own compilation, using the following sources: Chemie³'s Report 2013 and its Progress Report 2015
https://www.chemiehoch3.de/fileadmin/user_upload/downloads/CHEMIE3-NH-Publikation-EN.pdf
https://www.chemiehoch3.de/fileadmin/user_upload/downloads/Chemie3_Progress_Report_2015.pdf

6.4.2 Criteria

"Since early 2015, the Chemie³ alliance partners have been working on selecting suitable parameters, the so-called key performance indicators (KPI in short) to measure the progress of the Initiative. The basis for the selection of the indicators is the twelve Chemie³ Guidelines. The indicators also need to be measurable, collectible with reasonable effort, relevant, and conclusive. The alliance partners have taken on responsibilities in line with their core competencies. As the trade association and coordinator of Responsible Care, the VCI prepares indicators pertaining to the economic and environmental di-

mension. The social partners IG BCE and BAVC along with the Foundation Social Partners Academy (CSSA) jointly focus on social indicators. Both processes are closely coordinated. …

While there are already numerous indicators for the economic and environmental dimension that are partially based on legal stipulations, developing social indicators is a more complicated process. There are already existing parameters for this area, for instance the ILO core labor standards and the OECD guidelines at an international level. However, these are uncharted waters, because this is the first time social partners of an industry sector want to mutually agree on a definition of "social sustainability".[114]

Finally, on November 18, 2016, Chemie[3] launched its set of 40 indicators[115] to make German chemical industry's progress in sustainability measurable: "Sustainability is measurable: With 40 indicators, as developed by the sustainability initiative Chemie3 of the chemical-pharmaceutical industry in Germany, the progress of a sustainable development can be measured for the first time in the sector. ... The indicators cover economic, environmental and social criteria, ranging from the competitiveness of the chemical industry on global markets to greenhouse gas emissions and the percentage of young people who are offered permanent employment after an apprenticeship. The alliance partners have agreed on 17 indicators which are solely dedicated to social progress. This gives a pioneering role to chemistry in German industry as a whole ..."[116]

Table 35 gives a survey on the 40 indicators launched by Chemie[3] in November 2016. A detailed description including the calculation base of all 40 indicators is shown in Annex III: Chemie[3]: Progress indicators starting on page 221.

Table 35: Chemie[3]: Indicators for measuring progress in sustainabilit in the chemical-pharmaceutical industry [2016; translation by the author]

Cat.	No.	Short name	Indicator	Reference
OA	1	Companies having defined sustainability goals	Share of companies in sector having defined sustainability goals; of them publicly communicated goals	GRI G4
OA	2	Companies having established compliance processes	Share of companies in the sector having established processes to comply with laws and guidelines.	GRI G4, ISO 19600
OA	3	Companies with sustainability criteria in supplier selection	Share of companies in the sector which take into account sustainability criteria in the selection of suppliers in addition to the classic purchasing criteria price, quality and delivery conditions.	GRI G4
OA	4	Companies with public sustainability communication	Share of companies in the sector which publish information on essential ("material") sustainability issues.	--
OA	5	Companies with regular stakeholder exchange on sustainability issues	Share of companies in the sector with regular stakeholder exchange on sustainability issues	GRI G4
SO	6	Companies oriented /	Share of companies in the sector which are	Cf. Section

[114] https://www.chemiehoch3.de/fileadmin/user_upload/downloads/Chemie3_Progress_Report_2015.pdf

[115] Chemie[3]: Fortschrittsindikatoren-Steckbriefe (in German) https://www.chemiehoch3.de/fileadmin/user_upload/Chemie3_Fortschrittsindikatoren_Steckbriefe.pdf

[116] Chemie[3]: The German chemical industry makes sustainability measurable. Press Release, 18 November 2016 https://www.vci.de/langfassungen/langfassungen-pdf/2016-11-18-german-chemical-industry-makes-sustainability-measurable.pdf

Cat.	No.	Short name	Indicator	Reference
		commited to UN guiding principles for business and human rights or a comparable set of rules	oriented towards or committed themselves publicly to the UN Guiding Principles for Business and Human Rights or a comparable set of rules, such as the OECD Guidelines for Multinational Enterprises, the tripartite ILO Declaration on Multinational Enterprises and Social Policy or the UN Global Compact	289c (2) of the German Commercial Code
SO	7	Social partnerships	Social partnerships (joint social partner organizations, number of events and agreements between the social partners at sector level)	Cf. GRI G4
SO	8	Average wage per employee	Average wage per employee in the sector	Cf. GRI G4
SO	9	Collective bargaining agreements – Company	Share of companies in the sector with area tariff binding to the total number of companies in the sector	--
SO	10	Collective bargaining agreements – Employees	Share of employees in fixed-rate companies on the total number of employees in the sector	--
SO	11	Companies with a works council	Share of the companies in the sector with works council to the total number of companies in the sector	--
SO	12	Employees represented by a works council	Share of employees represented by a works council in proportion to the total number of employees in the sector	--
SO	13	Companies with collective bargaining / company pension scheme	Share of employees in the sector under collective bargaining and / or company pension schemes to the total number of employees in the sector	--
SO	14	Companies with an agreement on aging- and age-appropriate work	Share of the companies in the sector with agreements on aging- and age-appropriate work (e.g. within the framework of the "Working Life and Demography" collective agreement) to the total number of companies in the sector	Cf. GRI G4
SO	15	Companies offering health care and counseling services	Share of the companies in the sector offering health care and counseling services (e.g. within the framework of the "Working Life and Demography" collective agreement) to the total number of companies in the sector	Cf. SASB Chemical Standard
SO	16	Companies with flexible working time models	Share of the companies in the sector offering flexible working time models (e.g. part-time, flexible working hours, mobile work)	--
SO	17	Offered apprenticeships	Number of offered apprenticeships in the sector	Cf. GRI G4
SO	18	Takeover rate	Takeover rate: Number of trainees taken over in proportion to the number of trainees in the sector who have been ready to be taken over	--
SO	19	Places for training	Number of places for training preparatory	--

Cat.	No.	Short name	Indicator	Reference
		preparatory measures	measures in the sector	
SO	20	Investment in further training and development	Investments in the sector in further training and development (in euro)	Cf. GRI G4
SO	21	Companies with advanced training	Share of the companies in the sector which are practicing advanced training, to the total number of companies in the sector	Cf. GRI G4
SO	22	Activities to promote diversity and equal opportunities	Activities ot the chemical industry to promote diversity and equal opportunities (agreements between the social partners, allocation of the employees by category: gender, age group and nationality, Altersgruppe und Nationalität)	Cf. GRI G4
$	23	Gross value added	Gross value added by enterprises in the sector, in euro	GRI G4
$	24	Share in the gross value added by German industry	The share of the gross value added by companies in the industry in the total value added by German industry in percent	--
$	25	Investitionen	Investments of the companies of the chemical industry in Germany in euro (property, plant and equipment, environmental protection without R & D)	GRI G4
$	26	Global market share	Share of the chemical industry in world chemical exports in percent	--
$	27	Foreign trade balance	Foreign trade balance of the sector in euro	--
$	28	Expenditure for research and development	Expenditure of companies in the research and development sector	--
$	29	Newly registered patents	Number of worldwide patents newly registered by companies in the sector	--
$	30	Employees in research and development	Number of persons employed in the chemical and pharmaceutical industry in research and development	--
ECO	31	Companies with sustainability criteria in innovation and development processes	Share of companies in the sector, which systematically take into account sustainability criteria in innovation and development processes	--
ECO	32	Companies with management systems for updating or quality assurance of their REACH dossiers	Number of companies that have implemented management systems for updating or quality assurance of their REACH dossiers	SASB Chemical Standard
ECO	33	Published „GPS-Safety Summaries“	Number of published „GPS-Safety-Summaries“	Cf. GRI G4
ECO	34	Absolute greenhouse gas emissions (Scope 1 and 2)	Absolute greenhouse gas emissions from the chemical-pharmaceutical industry in Germany (Scope 1 and 2)	GRI G4
ECO	35	Greenhouse gas emissions per production	Greenhouse gas emissions from the chemical-pharmaceutical industry per product unit (i.e.	GRI G4

Cat.	No.	Short name	Indicator	Reference
		unit	energy-related CO_2 emissions + nitrous oxide emissions [N_2O] based on the production index, base year 2000 = 100)	
ECO	36	Companies that collect Scope 3 greenhouse gas emissions	Share of companies in the sector that capture Scope 3 greenhouse gas emissions for at least one category according to the Greenhouse Gas Protocol	GRI G4
ECO	37	Companies with efficiency targets for raw material use or waste quantities	Share of enterprises with efficiency targets for (specific) raw material input or (specific) waste quantities.	GRI G4
ECO	38	Specific raw material use in relation to the production index	Specific use of raw materials (use of petro-chemical raw materials based on the produc-tion index)	--
C3	39	Companies that know Chemie[3]	Share of enterprises in the sector, which know the initiative Chemie[3]	--
C3	40	Use of the support offers from Chemie[3]	Number of participants from companies of the sector at events of Chemie[3] and use or down-load of tools on the website of Chemie[3].	--

OA = Overarching, SO = Social, $ = Economic, ECO = Ecological, C3 = Chemie3's ability to mobilize
Own compilation, using the following sources: Chemie[3]: Fortschrittsindikatoren-Steckbriefe (in German)
https://www.chemiehoch3.de/fileadmin/user_upload/Chemie3_Fortschrittsindikatoren_Steckbriefe.pdf

6.4.3 Evaluation

Chemie[3] has selected 40 indicators for measuring the German chemical industry's progress on sustainability. They can be assigned to five categories, having a different number of indicators:

- social indicators 17
- economic indicators.....8
- ecological indicators 8
- overarching indicators 5
- indicators for Chemie[3]'s ability to mobilize 2

Nearly half of the indicators (21 out of 40) refer to international or national regulations on sustainability or non-financial reporting:

- indicators referring to GRI G4 18
- indicators referring to SASB 2
- indicators referring to others.....1 (German Commercial Code)
- indicators without reference.....19

More than half of the indicators are expressed as a percentage. Without specifying the totality, it is then not clear how meaningful these data are. This applies in particular to the 14 indicators whose data are collected by means of questionnaires and where the percentage refers to the number of returned questionnaires. The use of the set of indicators in practice should therefore be pursued.

Since methodological questions and the application of the criteria are still open, the Chemie[3] concept cannot be evaluated. Therefore, the corresponding table on evaluation is omitted.

6.5 European Technology Platform for Sustainable Chemistry (SusChem)

"SusChem is the *European Technology Platform* for Sustainable Chemistry. It is a forum that brings together industry, academia, governmental policy groups and the wider society." European Technology Platforms (ETPs) are industry-led stakeholder organizations, supported by both private and public funding, that develop long-term research and innovation agendas for action at European and national level.

"SusChem National Technology Platforms (NTPs) help to connect SusChem thinking with national and regional programmes, to facilitate trans-national collaboration and to advise SusChem at the European level on collective national priorities that need to be considered in European initiatives. SusChem NTPs are key to the involvement of national stakeholders including small and medium-sized enterprises (SMEs), large companies and academic groups, in European initiatives."[117] Currently, SusChem NTPs have been created in 14 countries: Austria, Belgium, France, Czech Republic, Germany, Greece, Italy, Netherlands, Poland, Romania, Slovenia, Spain, Switzerland and United Kingdom.

"SusChem's priority areas, led by industries, include Resource and Energy Efficiency, Water, Raw Materials, Smart Cities, Enabling Technologies and Education."[118] "SusChem is actively engaged in supporting EU-financed projects in research and innovation (Coordination Support Actions): BIO-TIC, R4R, E4Water, CRM_InnoNet – to name a few which aim at recommending policies to support innovation and meet societal challenges identified in Horizon2020. … As well as inspiring new research and innovation projects SusChem has provided a framework to bring academia and industry together. SusChem has enabled an improved industry involvement in European research projects and increased enthusiasm for European collaboration with national governments."[119]

"With its tools, such as the Cefic Grant-it initiative (http://www.grant-it.eu), SusChem can evaluate projects, help to develop proposals and suggest the most appropriate funding opportunities."[119]

Table 36 gives a short survey on SusChem. The informations are mainly based on SusChem's website[120].

Table 36: European Technology Platform for sustainable chemistry (SusChem): Short Characterization

Subject	Information
Name	**European Technology Platform for sustainable chemistry (SusChem)**
(Main) URL	http://www.suschem.org
Type of organisation	Multi-organisational
Coverage/region	Europe
Institution(s) behind initiative/approach	SusChem was founded by six European bodies which represented the main stakeholders from academia and industry in the sector: ► Cefic (European Chemical Industry Council), ► DECHEMA (German Society for Chemical Engineering and Biotechnology), ► EuropaBio (European Association for Bioindustries), ► GDCh (German Chemical Society), ► ESAB (European Federation of Biotechnology Section of Applied Biocatalysis),

[117] http://www.suschem.org/about-suschem/organisation-and-structure/national-technology-platforms.aspx
[118] http://www.suschem.org/about-suschem/vision-and-mission-sustainable-chemistry.aspx
[119] http://www.suschem.org/about-suschem/impact-of-suschem.aspx
[120] http://www.suschem.org

Subject	Information
	► RSC (Royal Society of Chemistry, UK) The European Commission has provided financial and consultative support.
Legal information	"From the beginning SusChem has been an open and inclusive organisation that works for and with its stakeholder constituencies. **SusChem is not established as a formal legal entity** and carries out its activities through its stakeholders. This encourages a highly collaborative approach."
Governance bodies	**SusChem Board**, manages SusChem's overall strategy and activities. **SusChem Management Team**, supported the activities of the board. **SusChem secretariat**, based at **Cefic**, provides support for both the board and management team.
President/CEO/Chairman	Dr. Klaus Sommer, Chairman of the Board; Bayer Technology Services
Year of foundation	2004
Budget/funding	n.a.
Links/closeness to other stakeholders	See founding bodies
Target audience and sectoral/geographical scope	Industry, academia, governmental policy groups and the wider society / Europe, see also the network of **National Technology Platforms (NTPs)** in 14 countries (Austria, Belgium, France, Czech Republic, Germany, Greece, Italy, Netherlands, Poland, Romania, Slovenia, Spain, Switzerland and United Kingdom)
Self-declared goal	"SusChem's mission is to **initiate and inspire European chemical and biochemical innovation** to respond effectively to society's challenges by providing sustainable solutions."
Definition of sustainable chemistry resp. sustainability	Follows **OECD definition of sustainable chemistry** (see sub-chapter 5) and proposes **LCA-approach**: "Essentially sustainable chemistry is about doing more with less: reducing the environmental impact of processes and products, optimizing the use of finite resources and minimizing waste. Sustainable chemistry can ensure eco-efficiency in everything we do, both individually and as a society. Sustainable chemistry also means protecting and extending employment, expertise and quality of life. It provides a sustainable basis for the innovation needed to stimulate a competitive, knowledge-based, enterprise-led economy across Europe. But solutions provided by sustainable chemistry must also be **acceptable to society**: they must be trusted and designed according to what society wants and needs and they must be economically sound. In practice, it means that SusChem projects and programmes should address clear societal needs, be environmentally sound and economically viable." [118]

Subject	Information
Concept of selected indicators	"This means that a truly sustainable innovation must meet three sets of criteria, which are that the innovation must be **environmentally sound, societally beneficial and economically robust**. ... The concept of what constitutes a truly sustainable invention or innovation is being further developed and articulated: Sustainable development remains at the core of our SusChem strategy but the issue of sustainability will now be more comprehensively addressed across environmental, societal and economic issues along the whole value chain in conjunction with our stakeholders, so that as far as possible SusChem activities fulfil concurrently sustainability criteria pertinent to each area. *A team within SusChem is working on this issue.*"[121]
Launch year, change in concept (if any) since then	2004
Proposed instruments and measures for implementation	"In order to meet the SusChem goals, innovate successfully and remain sustainably competitive the European chemical sector needs human resources equipped with the right mix of skills. Therefore, one of SusChem's priorities is to ensure higher education and the European chemical industry work together to build the skills capacity required for tomorrow. … SusChem has defined two priorities: ► Develop industry–academia cooperation on the provision of skills for innovation; ► Disseminate good practices in relation to teaching methodologies, curricula design, involvement of industry, and the value of active learning for teaching staff."[122]
Status of implementation (e.g. description of best practice, etc.)	**Educate to Innovate programme**[123]: The programme aims to establish a collaborative framework for building innovation skills capacity by: ► capturing innovations emerging from SusChem R&I projects that could be used as case studies for the development of educational resources ► facilitating constructive dialogue and exchange of ideas between stakeholders in industry and HEIs (higher education institutions) ► designing appropriate educational resources that can be used at undergraduate and Masters level to develop the skills needed to enhance innovation in the chemical and industrial biotechnology sectors.
Status and type of monitoring including e.g. time series of indicator measurements	n.a.
Stakeholder dialogue	"SusChem is an open organization with regular yearly stakeholders' meetings and brokerage events to boost collaboration between all the interested parties in the value-chain. The activity of the European organization is leveraged through the SusChem National Technology Platforms."

[121] SusChem Horizon 2020 Strategy. http://www.suschem.org/cust/documentrequest.aspx?UID=353c6fb4-bc22-4c79-b983-90c5d11ca8e6

[122] http://www.suschem.org/priorities/education.aspx

[123] http://www.suschem.org/priorities/education/educate-to-innovate.aspx

Subject	Information
	Last Stakeholder event in 2013 Social media: http://suschem.blogspot.de/
Additional information	**SusChem Strategic Innovation and Research Agenda** A framework for sustainable chemistry applies not just to the products themselves, but to the whole product life cycle, from cradle-to-grave. It means fully considering the impacts all along the value chain, from raw material sourcing, logistics, manufacture (cradle-togate), to product use and finally recycling or disposal processes (gate-to-grave). Note therefore that the SusChem approach to sustainable chemistry takes a value chain perspective, assessing social, environmental and economic sustainability and accounting for impacts as well as contributions to societal challenges. [124]

Own compilation, using the following source: SusChem's website http://www.suschem.org

As the criteria are currently not available, the concept cannot be evaluated. Therefore, the corresponding tables are omitted.

6.6 Interim conclusion on (chemical) industry approaches

Industry has no uniform definition of sustainable chemistry. ICCA, WBCSD, TfS and Chemie^3 refer more or less clearly to the triple-bottom line approach (economic, ecological, social). WBCSD proposes a life cycle approach (cradle-to-grave). The European Technology Platform for sustainable chemistry (SusChem) cites the OECD definition of sustainable chemistry, proposes an LCA-approach, too, and stresses the need of acceptance by society.

The development of indicators for measuring progress in the chemical industry is an ongoing process. Current reports on the sustainability progress of companies or sectors focus mainly on economic, ecological and social aspects. WBCSD offers some guiding documents for environmental aspects in the chemical industry, and is frontrunner with its guideline of 2016 on social life cycle metrics (its development was co-chaired by BASF, DSM and Solvay). ICCA periodically reviews its metrics to determine the need for any changes. SusChem will address sustainability more comprehensively across environmental, societal and economic issues along the whole value chain in conjunction with its stakeholders. Chemie^3 has published its cataloque of 40 indicators in late 2016. Since methodological questions and the application of the criteria are still open, the cannot be evaluated. The TfS approach to sustainability or to sustainable supply chains is of interest, but indicators are not available for the public.

7 Approaches from the upstream / downstream value chain

"Through their global supply chains, for example, companies have a growing impact on people's lives and on natural capital. There are companies today with revenues more than the GDP of countries. Companies have much more – global – impact than 50 or 100 years ago. And with this increasing impact comes a bigger responsibility, not just for financial but also for social and environmental issues."[125]

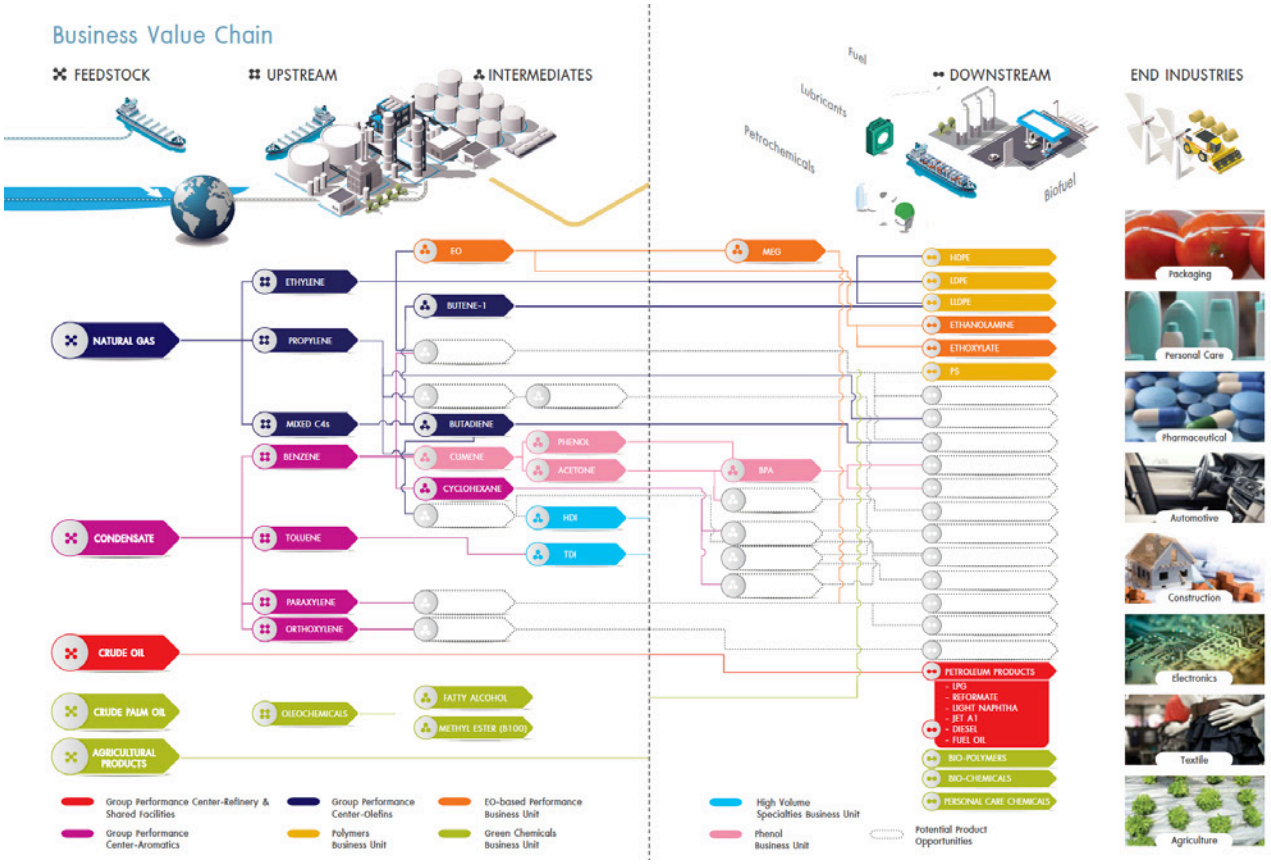
[124] SusChem Strategic Innovation and Research Agenda. Version 1.1 / 01.03.2015 http://www.suschem.org/cust/documentrequest.aspx?DocID=928

[125] Feike Sijbesma, CEO Royal DSM. Preface to the study „New era. New plan. EUROPE. A FISCAL STRATEGY FOR AN INCLUSIVE, CIRCULAR ECONOMY". The Ex'tax Project in cooperation with Cambridge Econometrics, Trucost, Deloitte, EY, KPMG Meijburg and PwC. http://www.neweranewplan.com/wp-content/uploads/2016/12/New-Era-New-Plan-Europe-Extax-Report-DEF.compressed.pdf

In this chapter, approaches from the upstream or downstream value chain are presented. Upstream approaches are those concerning the supply chain of chemical industry. This includes not only raw and auxiliary materials, precursors, intermediates and the final chemicals, but energy resources, packaging materials, logistics, service providers etc., too. The downstream value chain consists of other (chemical or industrial) companies using the produced precursors, intermediates, final chemicals or products, or commercial or private users. A chemical company can be both: Supplier for another company and producer of final products for other industries (see Figure 5).

Due to the revised scope of the study, approaches including certificates – e.g. CleanGredients®, Processed Chlorine Free (PCF) or Leadership in Energy and Environmental Design (LEED) – are excluded.

Figure 5: PTT Global Chemical PDL, Thailand: Business Value Chain



Source: PTT Global Chemical PCL: Integrated Sustainability Report 2015
http://www.pttgcgroup.com/src/download/sustain/20161006-pttgc-isr-2015.pdf

7.1 Zero Discharge of Hazardous Chemicals (ZDHC)

7.1.1 Characterization

"The Zero Discharge of Hazardous (ZDHC) Programme takes a holistic approach to tackling the issue of hazardous chemicals in the global textile and footwear value chain. … Our goal is to eliminate the use of priority chemicals by focussing on the following areas: Manufacturing Restricted Substances List (MRSL) & Conformity Guidance, Wastewater Quality, Audit Protocol, Research, Data and Disclosure, and Training."[126]

[126] http://www.roadmaptozero.com/

Manufacturing Restricted Substances List (MRSL) & Conformity Guidance | Wastewater Quality | Audit Protocol | Research | Data and Disclosure | Training

"Our vision is widespread implementation of sustainable chemistry and best practices in the textile and footwear industries to protect consumers, workers and the environment." [127]

The ZDHC Programme began in 2011 with six leading brands, and today consists of 22 signatory brands, 12 value chain affiliates and seven associates. Further details are provided in Table 37. Information was mainly sourced from ZDHC's website[128] and its Annual Reports 2012[129] and 2015[130].

Table 37: ZDHC Programme: Short Characterization

Subject	Information
Name/title	Zero Discharge of Hazardous Chemicals (ZDHC) Programme
URL	http://www.roadmaptozero.com/
Type of organisation	Foundation (since 2015)
Coverage/region	Global
Institution(s) behind initiative/approach	Stichting ZDHC Foundation, Amsterdam
Legal information	ZDHC is registered as a legal entity under Dutch law.
Governance bodies	The ZDHC Foundation oversees implementation of the ZDHC Programme.
President/CEO/Chairman	Frank Michel, Executive Director
Year of foundation	2011
Budget/funding	n.a.
Links/closeness to other stakeholders	Key stakeholders: IPE (Institute of Public & Environmental Affairs, Beijing), CNTAC (China National Textile and Apparel Council), OIA (Outdoor Industry Association), SAC (Sustainable Apparel Coalition)
Target audience and sectoral/geographical scope	Textile industry along the value chain (manufacturing suppliers, brands, retailers and chemical suppliers); global, with emphasis on Asia
Self-declared goal	"It is the Programme's vision to have the ZDHC MRSL and conformity

[127] http://www.roadmaptozero.com/about/
[128] http://www.roadmaptozero.com/
[129] ZDHC: Annual Report 2012. http://www.roadmaptozero.com/fileadmin/pdf/2014_Annual_Report.pdf
[130] ZDHC: Annual Report 2015. http://www.roadmaptozero.com/fileadmin/content/Annual_Report_2015_ZDHC.pdf

Subject	Information
	process guidance serve as the global textile and apparel industry standard." "2020: ZDHC audit is a recognised industry standard."
Definition of sustainable chemistry OR sustainability	"Based on these definitions [German Federal Environmental Agency, SusChem], **sustainable chemistry** represents the many over-arching aspects of sustainability related to chemistry including but not limited to: government policy, socioeconomic issues, resource efficiency, product stewardship, and use of efficient, effective, safe and more environmentally benign chemical products and processes (i.e., green chemistry)." [129]
Concept of selected indicators	Manufacturing Restricted Substances List (MRSL): List of chemical substances banned from intentional use in facilities that process textile materials and trim parts in apparel and footwear; it establishes acceptable concentration limits for these substances as impurities or by-products in chemical formulations used within manufacturing facilities.
Launch year, change in concept (if any) since then	2014: First MRSL published 2015: MRSL V1.1[131] (expanded the original list to include leather)
Proposed instruments and measures for implementation	Audit, using the ZDHC audit protocol, supported by the ZDHC Chemical Management System (CMS) Guidance Manual, released in 2015. Training in five priority countries: China, Bangladesh, India, Vietnam and Turkey.
Status of implementation (e.g. description of best practice etc.)	"Success in this focus area will be measured by widespread industry adoption of the ZDHC Audit Tool as the global textile and footwear standard, and extensive use of the tool by all tiers of the value-chain." [130]
Status and type of monitoring including e.g. time series of indicator measurements	Work in progress.
Stakeholder engagement	E.g. stakeholder consultation on the first Joint Roadmap, conducting of stakeholder meetings, webinars, and consultations related to the Joint Roadmap, programme updates, and individual projects, engaging key technical stakeholders in several projects and through a technical advisory committee, engaging with industrial groups such as Sustainable Apparel Coalition (SAC) and the OIA CMWG (Outdoor Industry Association' Chemicals Management Working Group) to ensure alignment with ZDHC's Programme efforts etc.[129]
Additional information	ZDHC CHEMICAL GATEWAY: A new open database of safer chemistry to assist better sourcing decisions http://gateway.roadmaptozero.com/

Own compilation, using the following source: ZDHC's website and its Annual Reports 2012 and 2015
http://www.roadmaptozero.com/
http://www.roadmaptozero.com/fileadmin/pdf/2014_Annual_Report.pdf
http://www.roadmaptozero.com/fileadmin/content/Annual_Report_2015_ZDHC.pdf

[131] http://www.roadmaptozero.com/fileadmin/pdf/MRSL_v1_1.pdf

7.1.2 Criteria

The Manufacturing Restricted Substances List (ZDHC MRSL V1.1[131]) is a list of chemical substances banned from intentional use in facilities that process textile materials and trim parts in apparel and footwear.

"The MRSL was developed in collaboration with the ZDHC Technical Advisory Committee (representatives of the chemical industry) and peer reviewed by industry-leading experts at bluesign® and the Leather Working Group. The MRSL Version 1.1, which is already under development, includes feedback from the China Textile Auxiliary Standardization Subcommittee, China National Textile and Apparel Council and several Asia-based chemical suppliers …" [132].

"The ZDHC MRSL includes relevant substances from the original 11 priority chemical groups in the Joint Roadmap[133] …. Several of the listed substances are regulated in finished products and have been successfully restricted by ZDHC brands for years. Though already restricted by ZDHC brands, their inclusion on the list keep it consistent with existing industry standards. Where possible, the content of the ZDHC MRSL was peer-reviewed by independent third-party technical experts and industry associations related to the production of our key raw materials. Collaboration with leading technical experts allows the ZDHC Programme to develop a MRSL that pragmatically represents progress and supports our long-term goal of zero discharge."[131]

"The MRSL establishes acceptable concentration limits for substances in chemical formulations used within manufacturing facilities. The limits are designed to eliminate the possibility of intentional use of listed substances. The intent of the MRSL is to manage the input of chemicals to the suppliers and remove those hazardous substances from the manufacturing process. It is a living document and will be updated as needed to expand the materials and processes covered and to add substances that should be phased out of the value-chain."[134]

"Note: The ZDHC MRSL does not replace applicable national environmental or workplace safety restrictions. Worker exposure to chemical substances listed in this document, along with other hazardous substances, must not exceed occupational exposure limits. Chemical formulations also must comply with all applicable legal restrictions, including any subsequent restrictions that establish more strict limits. The ZDHC MRSL does not replace legal or brand-specific restrictions on hazardous substances in finished products."

In the Annual Report 2015, the next steps are announced:

- The MRSL conformance process will be finalised and published in 2016. It will describe how the valuechain can assess claims of conformance with the MRSL by chemical suppliers.
- ZDHC brands will continue implementing the ZDHC MRSL in their valuechains.
- The annual review of the MRSL will be conducted. A transparent process will be used to update the MRSL as needed to cover additional materials and chemical substances.
- ZDHC will explore ways to scale adoption of the MRSL outside of ZDHC brands.

7.1.3 Evaluation

"The ZDHC Programme was born from an awareness that holistic systems-change is required, and that to be successful all participants within the value-chain must be involved." This approach is being followed successfully, as shown by the collaboration with currently 22 signatory brands, 13 value chain

[132] ZDHC: Annual Report 2014. http://www.roadmaptozero.com/fileadmin/pdf/2014_Annual_Report.pdf

[133] 1. Alkylphenol Ethoxylates/Alkylphenols (APEOs/APEs), 2. Brominated and Chlorinated Flame Retardants, 3. Chlorinated Solvents, 4. Chlorobenzenes, 5. Chlorophenols, 6. Heavy Metals, 7. Organotin Compounds (e.g., TBT), 8. Perfluorinated Chemicals (PFCs), 9. Phthalates (ortho-phthalates), 10. Short-Chained Chlorinated Paraffins (SCCPs), 11. Toxic Azo Dyes

[134] http://www.roadmaptozero.com/programme/manufacturing-restricted-substances-list-mrsl-conformity-guidance/

affiliates, and seven associates. But the final goal "2020: ZDHC audit is a recognised industry standard" is very ambitious.

The MRSL refers to hazardous chemicals and therefore covers an aspect of green chemistry that is – in the understanding of the project – one essential part of sustainable chemistry (see definition). The exclusion or minimization of hazardous chemicals is consistent with the concept (**Zero** Discharge of Hazardous Chemicals).

"A sound chemical management system is paramount to worker safety and will reduce environmental impacts on the community and the broader environment. A CMS is therefore one of the cornerstones for ensuring continuous improvement towards our 2020 goal of zero discharge of hazardous chemicals throughout the life cycle of our products."[135] ZDHC has therefore developed the ZDHC Chemical Management System (CMS) Guidance Manual that focuses on the approach, structure and documentation needed to create and support a Zero Discharge of Hazardous Chemicals (ZDHC) Programme CMS. In addition, an audit protocol provides brands with the capability to initiate and self-assess safe handling of chemicals with objectives at foundational, progressive and aspirational levels. The CMS Guidance Manual is available on the ZDHC website[135]. The Audit Protocol tool package is only available to ZDHC signatory brands and value chain affiliates.

On the other hand, some questions are still open. Are the commercial formulation limit values identical to analytical detection limits? Why are there no limits for wastewater or sewage sludge? Such values can be controlled more easily and allow further surveillance. For example, the MSRL of the Italian Detox campaign, launched in 2016, prescribes that all chemicals have to be tested in the input formulations, output discharge (wastewater and sludge) and products.[136]

ZDHC'S CMS Guidance Manual says that companies should prepare an accurate chemical inventory using mass balance (2.1.4.1.1), and that industry should also establish RSL limits for finished products. "A typical RSL sets concentration limits for substances in materials or finished products to comply with product regulation and safety standards. … Your facility may have several customer MRSLs and RSLs. Your team should harmonise these lists into one (1) factory MRSL and RSL using the most stringent standard of those available. This harmonised list should be communicated and distributed to all chemical suppliers to ensure that the chemicals supplied meet all the facility needs to operate more safely and in conformance with regulations."[135] Would it not be easier to set uniform limits for all suppliers?

ZDHC is a voluntary approach and needs the support of the brands. In the last five years, the number of brands that signed ZDHC increased from six to 22. Currently, competing projects like Detox (originally started by Greenpeace) are supported by relevant actors. For example, in February 2016, 20 manufacturing companies in Prato and the surrounding region and members of Confindustria Toscana Nord endorsed the Detox commitments, in March, a further seven companies signed, thereby significantly increasing the volumes of the products reached by the Detox commitment. In contrast to ZDHC, this campaign is supported by Greenpeace.[137] It is therefore a challenge for ZDHC to prove that it provides the same level of protection.

[135] ZDHC: Chemical Management Systems Guidance Manual 2015. http://www.roadmaptozero.com/fileadmin/layout/media/downloads/en/CMS_EN.pdf

[136] Confindustria Toscana Nord: Detox MRSL 08062015. https://www.confindustriatoscananord.it/media/DETOX/DetoxMRSL_PUBBLICA.pdf

[137] Sustainability of textile supply chain: https://www.confindustriatoscananord.it/sostenibilita/detox/english-version

Table 38: Evaluation of the ZDHC approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	MRSL refers to hazardous chemicals, an aspect of Green Chemistry. Green Chemistry is regarded as part of Sustainable Chemistry. No criteria for other sustainability aspects.
Consistency of indicator concept and how it is monitored	Exclusion or minimization of hazardous chemicals is consistent with the concept, though questions remain open (limits, discharges). Monitoring: By the brands themselves. Supporting material: ZDHC Chemical Management System (CMS) Guidance Manual and Audit Protocol tool package
Role of SDGs in the concept	n.a.
Probability of implementation	Work in progress, but the 2020 goal is very ambitious.
Overall impression	Can be a useful tool for reducing the number and volume of hazardous chemicals in manufacturing processes and products. Has to prove that it provides the same level of protection as the Detox commitment of Confindustria Toscana Nord.

Source: Own compilation

7.2 Clean Production Action/BizNGO

7.2.1 Characterization

BizNGO – a Clean Production Action[138] programme – is a collaboration of business and NGO leaders. Its mission is to promote the creation and adoption of safer chemicals and sustainable materials. Currently, it has four active Work Groups:

- Safer Chemicals: "The BizNGO Chemicals Work Group focuses on chemicals management and metrics. We work on practical ways to implement the BizNGO Principles for Safer Chemicals."[139]
- Alternatives Assessment: "The BizNGO Alternatives Assessments Work Group developed the Commons Principles of Alternatives Assessment and focuses its work on real world applications of finding safer alternatives to toxic chemicals."[140]
- Sustainable Materials: "The BizNGO Sustainable Materials Work Group developed the Principles for Sustainable Plastics and the Plastics Scorecard."[141]
- Policy: "The BizNGO Policy Work Group primarily focuses its efforts on state-level chemicals policies, such as the California Safer Consumer Products Act."[142]

Further details are provided in Table 39. Information was mainly sourced from BizNGO's website[143].

[138] http://www.cleanproduction.org/programs
[139] http://www.bizngo.org/safer-chemicals
[140] http://www.bizngo.org/alternatives-assessment
[141] http://www.bizngo.org/sustainable-materials
[142] http://www.bizngo.org/public-policies
[143] http://www.bizngo.org

Table 39: BizNGO: Short Characterization

Subject	Information
Name/title	BizNGO
URL	http://www.bizngo.org
Type of organisation	BizNGO is an informal network rather than a membership organization.
Coverage/region	Global (?)
Institution(s) behind initiative/approach	Clean Production Action http://www.cleanproduction.org/
Legal information	BizNGO is a project of Clean Production Action.
Governance bodies	Steering Committee (6 members)
President/CEO/Chairman	Dr. Mark S. Rossi, project lead (Executive Director, Clean Production Action)
Year of foundation	2006
Budget/funding	"Clean Production Action staffs BizNGO and raises money for its work from foundations and through our annual meeting."
Links/closeness to other stakeholders	Clean Production Action http://www.cleanproduction.org/
Target audience and sectoral/geographical scope	Producers, designers, retail, consumers, NGOs, policy
Self-declared goal	"To promote the creation and adoption of safer chemicals and sustainable materials, thereby creating market transitions to a healthy economy, healthy environment, and healthy people".
Definition of sustainable chemistry OR sustainability	None.
Concept of selected indicators	E.g.: Principles for Sustainable Plastics:[144] ► Sustainable Resources ► Closed Loop Systems ► Energy Efficient & Renewable ► Safer Chemicals ► Healthy Workplaces and Communities
Launch year, change in concept (if any) since then	E.g. Sustainable Plastics: 2014 [146]
Proposed instruments and measures for implementation	"Promoting the creation and adoption of safer chemicals and sustainable materials, thereby creating market transitions to a healthy economy, healthy environment, and healthy people." "We achieve our mission through the co-development of principles, policies, strategies, and technical resources."

[144] BizNGO: Principles for Sustainable Plastics. Undated. http://www.bizngo.org/static/ee_images/uploads/resources/cpa-plastic-principles-bizngo.pdf

Subject	Information
Status of implementation (e.g. description of best practice etc.)	Various ongoing projects, e.g. ► Cutting Edge Sector Initiatives http://www.biznGO.org/safer-chemicals/cutting_edge ► A list of Corporate Chemical Policies influenced by BizNGO: http://www.biznGO.org/safer-chemicals/corporate-policies ► Case studies http://www.biznGO.org/safer-chemicals/case-studies
Status and type of monitoring including e.g. time series of indicator measurements	n.a.
Stakeholder engagement	Last Annual Meeting was in 2013. 2016 meeting is on 12/7-12/8/2016. More: Clean Production Action http://www.cleanproduction.org/
Additional information	► Further CPA programmes are ► GreenScreen® for Safer Chemicals http://www.greenscreenchemicals.org/ ► Chemical Footprint Project http://www.chemicalfootprint.org/

Own compilation, using the following source: BizNGO's website http://www.biznGO.org/

7.2.2 Application

BizNGO has published its "Principles for Sustainable Plastics" (publication date not available). Their purpose is to provide the foundation for a BizNGO framework that evaluates, identifies and selects more sustainable plastics. "The BizNGO Principles for Sustainable Plastics have been informed by and incorporate concepts from the: 1) 12 Principles of Green Chemistry, 2) Organization of Economic Co-operation and Development Sustainable Materials Management Principles, 3) Cradle-to-Cradle Design Principles, 4) Guidelines for Sustainable Biomaterials and 5) Lowell Center Framework for Sustainable Products."[144]

"This framework will evaluate materials to the extent that they achieve the following five principles.

1. Sustainable Resources
2. Closed Loop Systems
3. Energy Efficient & Renewable
4. Safer Chemicals
5. Healthy Workplaces and Communities"

Concerning the fourth principle – Safer Chemicals – it is pointed out: "A plastic should be manufactured using inherently safer chemicals and processes. The byproducts and waste streams from manufacturing along with the degradation and transformation products from use and end-of-life management should be inherently safer and in balance with natural systems[145]."

In June 2014, the Plastics Scorecard v1.0 was published. It is described as "the result of years of discussions, debates, pilots, and drafts on how best to integrate concerns with human health and the environment as well as desires for safer chemicals across the life cycle of plastics into a robust, replica-

[145] „Chemicals that are in balance with natural systems are those that do not cause eutrophication; do not bioaccumulate, deplete the ozone layer or contribute to climate change; and do not have the properties of a chemical of high concern as defined above."

ble, and transparent method that will ideally shape how manufacturers and markets develop and select plastic products." [146]

"The Plastics Scorecard v1.0 differentiates between chemicals used in polymer manufacturing and contained in the final plastic product, creating methods that score:

1. polymers on their progress to safer chemicals in the core steps of polymer manufacturing; and
2. plastic products on their chemical footprint.

The Progress to Safer Chemicals in Polymer Manufacturing Score assesses the hazards associated with polymer manufacturing by evaluating the core chemical inputs of the manufacturing process: Primary chemicals, intermediate chemicals, and monomers. For example, in evaluating the manufacture of the polymer, polystyrene, v1.0 scores each stage of manufacturing based on the hazards of the primary input chemicals and then aggregates them into a single score that ranks polymers from 0 (most hazards) to 100 (most benign). Polystyrene, for example, was scored based on its primary chemicals of ethylene and benzene, its intermediate chemical of ethylbenzene, and its monomer of styrene.

The Chemical Footprint of Plastic Products scores products on both the number and percent by weight of CoHCs[147] in a final, plastic product." Plastic products contain intentionally added chemicals – polymers and additives – and to a lower extent residues from manufacturing, such as processing aids, unreacted monomer, residual catalysts, and oligomers.

"The method for calculating the Chemical Footprint of a Plastic Product is easy to state but difficult to implement:

- Identify the chemicals in the product down to 1000 ppm for intentionally added chemicals.
- Identify which of the intentionally added chemicals are CoHCs. A reference source for identifying CoHCs is the Pharos chemical and material library. Take the list of chemicals in the product and use the Pharos database to identify which chemicals are a GreenScreen® Benchmark 1 or Possible Benchmark 1 chemical.
- Research through suppliers and the technical literature CoHCs likely to be in the plastic product.
- Work with suppliers to disclose CoHCs in the product down to 100 ppm.
- List number of CoHCs in product and percent or volume by weight."

The hazards posed to human health or the environment by each chemical are assessed using the GreenScreen® for Safer Chemicals (http://www.greenscreenchemicals.org/). Version 1.0 of the Plastics Scorecard assessed ten polymers and their core chemical inputs. The method applied to create the Progress to Safer Chemicals in Polymer Manufacturing Score and the data sources are described in detail in the Scorecard. Table 40 shows the score for 10 polymers. An ideal polymer (best case) based on low hazard chemicals would score 100.00.

Table 40 "reflects the reality that today's polymers are not based on green chemistry. Five of the ten polymers score zero: ABS, PC, PS, PVC, and SBR. That means each stage of manufacturing uses as a primary input a chemical of high concern. PLA, PE, and PP are making the greatest progress to safer chemicals in manufacturing, while EVA and PET are making some progress beyond chemicals of high concern."

[146] Clean Production Action: Plastics Scorecard. Evaluating the Chemical Footprint of Plastics. Version 1.0. Mark S. Rossi, Ph.D. and Ann Blake, Ph.D., July 1, 2014

[147] „BizNGO defines a "chemical of high concern" as having the following properties: 1) persistent, bioaccumulative and toxic (PBT); 2) very persistent and very bioaccumulative (vPvB); 3) very persistent and toxic (vPT); 4) very bioaccumulative and toxic (vBT); 5) carcinogenic; 6) mutagenic; 7) reproductive or developmental toxicant; 8) endocrine disruptor; or 9) neurotoxicant. Toxic, or T, includes both human toxicity and ecotoxicity."

"In terms of the chemicals in products, additives are the key driver affecting the Chemical Footprint of Plastic Products. Residing in the product in the greatest concentrations beyond the polymer, additives dictate the concentration of CoHCs in plastic products. Companies are reducing CoHCs in plastic products by eliminating the need for the additive, changing additives, or changing polymers to avoid the need for the additive in the first place.

The chemical footprints of IV (= intravenous) bags and electronic enclosures clearly demonstrate that material designers and purchasers can select alternative products that avoid most CoHCs and can document that progress. Plastic markets are shifting more quickly to safer additive packages because that is the often the easiest route to reducing the chemical footprint of a plastic product."

"Among the challenges of effectively evaluating the hazards of additives include the absence of relevant publically available data for the various additive chemistries. … The knowledge gaps on chemicals in additive packages will become increasingly significant along with the necessity for full hazard assessments of the substitutes. Additives are another area ripe for research and green chemistry solutions."

Five questions/instructions are given as solutions:

- First ask, is it necessary?
- Use safer additives.
- Use safer polymers.
- Close the loop and use post-consumer recycled (PCR) content (but beware of legacy CoHCs[148]).
- Redesign the product.

7.2.3 Evaluation

The Plastic Scorecard v1.0 only deals with one – but of course important – aspect of Green Chemistry. The methodology can be questioned. For example, all steps are considered to be of equal weight (see note below Table 40). A description of how the other principles are realized (and how to deal with contradictions) is not available. For example, the feedstock question (fossil/non-fossil) is not included. Concerning additives, there are knowledge gaps, as relevant data for the various additive chemistries are often not available publicly.

[148] „... PCR content is challenged by the legacy of the past use of CoHCs in plastics manufacturing."

Table 40: Plastics Scorecard v1.0: Progress to Safer Chemicals in Polymer Manufacturing

Polymer	Polymer Manufacturing: Progress to Safer Chemicals Score				Number of Primary Chemicals, Intermediates, and Monomers that are Chemicals of High Concern
	Primary Chemicals	Intermediate Chemicals	Monomer(s)	Total Manufacturing	
Best Case Polymer	33.33	33.33	33.33	100.00	0
Polylactic Acid (PLA)	25.00	16.67	16.67	58.33	0
Polyethylene (PE)	16.67	16.67	16.67	50.00	0
Polypropylene (PP)	16.67	16.67	16.67	50.00	0
Ethylene Vinyl Acetate (EVA)	0.00	16.67	0.00	16.67	2
Polyethylene Terephthalate (PET)	0.00	0.00	8.33	8.33	3
Polystyrene (PS)	0.00	0.00	0.00	0.00	3
Polyvinyl Chloride (PVC)	0.00	0.00	0.00	0.00	3
Styrene Butadiene Rubber (SBR)	0.00	0.00	0.00	0.00	4
Acrylonitrile Butadiene Styrene (ABS)	0.00	0.00	0.00	0.00	5
Polycarbonate (PC)	0.00	0.00	0.00	0.00	8

Green	The manufacture of the ideal polymer uses green chemicals as defined by GreenScreen® Benchmark 4 in each manufacturing step.
Yellow	For each manufacturing step, no core chemical inputs are chemicals of high concern as defined by GreenScreen® Benchmark 1.
Orange	Some manufacturing steps include chemicals of high concern as defined by GreenScreen® Benchmark 1, and others do not.
Red	Every manufacturing step involves the use of chemicals of high concern as defined by GreenScreen® Benchmark 1.
Grey	Manufacturing step involves the use of chemicals determined to be „unspecified“ due to the lack of complete hazard data using GreenScreen®.
Notes	• Only the principal input chemicals are included in this analysis (see Appendix 3). • For each step, the score is based on the worst performing chemical for human and environmental health. Thus, if any step includes a chemical of high concern, then it receives a zero. • All steps are considered of equal weight and are scaled to 100 – with the green polymer scoring „10“ and the red polymer scoring „0“.

Source: Clean Production Action: Plastics Scorecard. Evaluating the Chemical Footprint of Plastics. Version 1.0. Mark S. Rossi, Ph.D. and Ann Blake, Ph.D., July 1, 2014

Table 41: Evaluation of the approach of the Plastic Scorecard v1.0

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No definition, project mainly refers to hazardous chemicals (CoHC) / Green Chemistry
Consistency of indicator concept and how it is monitored	n.a.
Role of SDGs in the concept	n.a.
Probability of implementation	Applicability shown for IV bags and plastic electronic enclosure. Other aspects (functionality, costs, legal framework) are strong driving forces for manufacturers and markets.
Overall impression	Can be a useful tool for reducing the number and volume of CoHCs in manufacturing processes and products. How to deal with knowledge gaps?

Source: Own compilation

7.3 Chemicals Policy Initiative at the Lowell Center for Sustainable Production

7.3.1 Characterization

"The Lowell Center for Sustainable Production promotes communities, workplaces, and products to be healthy, humane, and respectful of natural systems. We promote environmentally sound systems of production and consumption by using rigorous science and innovative strategies to develop practical solutions. …

We are committed to a broad, global transition to sustainable materials, production processes, and conditions of life and work. This commitment led us to found the Lowell Center for Sustainable Production at the University of Massachusetts Lowell 1996."[149]

"The Lowell Center developed eight big goals to tackle issues that will make a major impact towards assuring future generations the just and sustainable life they deserve:

- Goal 1: Enact a comprehensive chemicals policy law in the United States that protects human health and the environment.
- Goal 2: Eliminate known cancer- and asthma-causing chemicals in manufacturing and commerce as part of a larger effort to reduce all diseases linked to toxic exposures.
- Goal 3: Ensure that sustainable biobased materials make up at least one fifth of the global chemical market and that infrastructure is in place for appropriate reuse, composting, and recycling.
- Goal 4: Integrate sustainability principles into product design, production, and practice in at least one third of US firms.
- Goal 5: Ensure that one-third of products readily found in stores are environmentally sound and affordable.
- Goal 6: Double healthcare resources devoted to eliminating environmental hazards that cause chronic diseases.
- Goal 7: Implement sustainable healthcare programs in at least half of US healthcare facilities.
- Goal 8: Re-orient federal research funding on environment and health to emphasize the search for sustainable solutions to the global environmental crisis."[150]

[149] http://www.sustainableproduction.org/abou.who.php?pid=142

[150] http://www.sustainableproduction.org/abou.goal.php

More details can be found in Table 42. Information was mainly sourced from the Lowell Center's website.[151]

Table 42: Characterization of the Lowell Center for Sustainable Production

Subject	Information
Name/title	Lowell Center for Sustainable Production
URL	http://www.sustainableproduction.org
Type of organisation	n.a.
Coverage/region	USA
Institution(s) behind initiative/approach	University of Massachusetts Lowell
Legal information	n.a.
Governance bodies	n.a.
President/CEO/Chairman	Ken Geiser, Lowell Center Co-Director and Professor of Work Environment
Year of foundation	1996
Budget/funding	n.a.
Links/closeness to other stakeholders	Partner institution: The Massachusetts Toxic Use Reduction Institute (http://www.turi.org/). Green Chemistry and Commerce Council (the GC3 is facilitated by the Lowell Center) (see sub-chapter 4.3.3)
Target audience and sectoral/geographical scope	"The Center is composed of faculty, staff, and graduate students at the University of Massachusetts Lowell who work collaboratively with citizen groups, workers, businesses, institutions, and government agencies to build healthy work environments, thriving communities, and viable businesses that support a more sustainable world."
Self-declared goal	"We are committed to a broad, global transition to sustainable materials, production processes, and conditions of life and work."
Definition of sustainable chemistry OR sustainability	**No definitions of sustainable chemistry.** The challenge of reconciling societal aspirations and environmental limits is captured by the term "sustainability." [152] **"What is a Sustainable Product?** For a product to be truly sustainable, it needs to be healthy for consumers, safe for workers who make the product, and not harmful to the ecosystems and communities that interact the product throughout its life cycle. **Sustainable products:** ► Minimize environmental and social costs throughout the product life cycle

[151] http://www.sustainableproduction.org

[152] The Sustainable Solutions Agenda. By Daniel Sarewitz, Kavid Kriebel, Richard Clapp, Cathy Crumbley, Polly Hoppin, Molly Jacobs, and Joel Tickner. In collaboration with the Consortium for Science, Policy and Outcomes, Arizona State University. June 2010 http://www.sustainableproduction.org/downloads/SSABooklet.pdf

Subject	Information
	► Maximize environmental and social benefits to communities ► Remain economically viable" [153]
Concept of selected indicators	The Lowell Center Framework for Sustainable Products (see 7.3.2)
Launch year, change in concept (if any) since then	2009
Proposed instruments and measures for implementation	n.a.
Status of implementation (e.g. description of best practice etc.)	The Framework for Sustainable Products was used in different projects, e.g. Lead-free electronics, sustainable biomaterials, green cleaning in hospitals or sustainable design and development of children's products.
Status and type of monitoring including e.g. time series of indicator measurements	n.a.
Stakeholder engagement	"The Sustainable Products Project of the Lowell Center promotes the sustainable design and development of safer, healthier, and greener products through engaging stakeholders, conducting research and providing information that can spark innovative, environmentally sound solutions."
Additional information	"The Chemical Footprint Project, launched in June 2015, provides the first-ever common metric for benchmarking companies' management and use of chemicals, and evaluating how they are responding to the increasing market demand for safer products." More information: Annex VI: Chemical Footprint Project (cfp), page 254

Own compilation, using the following source: Website of Lowell Center for Sustainable Production http://www.sustainableproduction.org

7.3.2 Criteria

"Sustainable Production is the creation of goods and services using processes and systems that are:

- Non-polluting
- Conserving of energy and natural resources
- Economically viable
- Safe and healthful for workers, communities, and consumers
- Socially and creatively rewarding for all working people." [154]

The characteristics and criteria of Lowell Center's framework for Sustainable Products[155] are shown in Table 43.

[153] http://www.sustainableproduction.org/proj.SustainableProductsInitiative.php

[154] http://www.sustainableproduction.org/abou.what.php

[155] The Lowell Center for Sustainable Production: A New Way of Thinking: The Lowell Center Framework for Sustainable Products (2009). http://www.sustainableproduction.org/downloads/LowellCenterFrameworkforSustainableProducts11-09.09.pdf

Table 43: Lowell Center: Framework for Sustainable Products

Characteristic	Criteria
Healthy for consumers A sustainable product is healthy for consumers. This means:	► It avoids chemicals that cause cancer or mutations, damage the reproductive, nervous, endocrine or immune systems, are acutely toxic or accumulate or persist in the environment. ► It is safe in use – not flammable, explosive or corrosive, does not cause lacerations, choking or strangling, burns/shocks, damage hearing or injure eyes.
Safe for workers A sustainable product is safe for workers. This means:	► Workplace is safe: Clean, well lit, ventilated, with good air quality, well designed ergonomically, free of exposure to toxins, equipped for fire safety and other emergencies. ► Workers receive adequate health and safety training. ► Working hours and pace are not excessive. ► Workers have some job control and input into production process. ► If workers are housed in dormitories, the living quarters are clean, and workers have sufficient food, access to potable water and sanitation. ► Workers are treated fairly and with respect and dignity; there is no corporal punishment, verbal abuse, coercion, discrimination or harassment. ► Child or forced labour is not permitted. ► Workers have freedom of association and the right to collective bargaining. ► Employees' skills are well utilized and their ideas and input are valued. ► Communication is valued and encouraged among workers and management.
Environmentally sound A sustainable product is environmentally sound. This means:	► Chemical and material inputs/outputs are not hazardous (see Healthy for consumers above). ► Product is energy, water, and materials efficient in production and use. ► Waste is prevented and/or minimized throughout the product lifecycle. ► Product and packaging are durable as appropriate, and are reused, repaired, recycled or composted. ► Product is designed for disassembly – it can be taken apart and remanufactured. ► Renewable resources and energy are utilized in production and use. ► Scarce resources are conserved and ecosystems are not damaged in extracting resources for production. ► Critical habitats are preserved during extraction, production, and use.
Beneficial to local communities A sustainable product benefits the communities in which it is made. This means:	► Workers receive a living wage and can support their families without additional government assistance. ► The work design is supportive to family life – e.g., families are not separated, and good-quality childcare is available for workers' children. ► The work design promotes equity and fairness in the community – e.g., there is no age or gender discrimination. ► Some of the firm's profits accrue to the local community to be used for public improvements (such as in education, health care). ► The work design promotes community input and participation and the community is informed about production and labour practices.
Economically viable A sustainable product is economically viable	► The product is responsive to market requirements. ► Innovation is encouraged to anticipate market needs. ► The firm is stable in terms of ownership and philosophy.

Characteristic	Criteria
for the firm / organization. This means:	► The company reinvests in the facility to improve its capacity for further production. ► The product is priced for economic viability and also aims to internalize costs so that its production can be environmentally sound and socially just. ► The firm is recognized for its **corporate social responsibility**: This includes programmes that support and value employees as well as programmes that benefit the community and environment.

Own compilation, using the following source: The Lowell Center for Sustainable Production: A New Way of Thinking: The Lowell Center Framework for Sustainable Products (2009).
http://www.sustainableproduction.org/downloads/LowellCenterFrameworkforSustainableProducts11-09.09.pdf

There are no metrics proposed for measuring or comparing the "sustainability" of products. On the other hand, many of these criteria are the subject of GRI reporting. While there is a direct link to corporate social responsibility (see last bullet point in Table 43), no reference is made to the Global Reporting Initiative's reporting guideline published three years before (GRI G.3). Especially governance aspects are lacking.

7.3.3 Evaluation

Detailed information on metrics is not available. The Framework for Sustainable Products was used in different projects, e.g. lead-free electronics, sustainable biomaterials, green cleaning in hospitals or sustainable design and development of children's products. In addition, The Lowell Center for Sustainable Production facilitated an industrial group called the Green Chemistry and Commerce Council (GC3) that supports the use of Green Chemistry and design for environment practices in the development of sustainable products (see sub-chapter 4.3.1).

Table 44: Evaluation of the Lowell Center approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of Sustainable Chemistry. The criteria for sustainable products (economic, environmental or social) are part of CSR. Governance aspects are lacking.
Consistency of indicator concept and how it is monitored	No detailed indicators available.
Role of SDGs in the concept	None (MDGs: None)
Probability of implementation	Implemented in some projects.
Overall impression	Interesting approach, but more details are needed, especially regarding the metrics.

Source: Own compilation

7.4 Further supply chain Initiatives

The UN GC guide on Supply Chain Sustainability[103] contains a list of further industrial collaborations on sustainable supply chains, some of them close to the chemical industry.

7.4.1 Pharmaceutical Supply Chain Initiative (PSCI)

„The PSCI was formed as a non-profit business membership organization in 2006 and is legally established in the United States. Our vision is to create better social, economic, health, safety and environ-

mental outcomes for all those involved in the pharmaceutical supply chain. ... Our mission is to establish formal industry guidelines about *ethics*, *labor*, *health & safety*, *the environment* and *management systems* and support suppliers to build capacity to operate in a manner consistent with those expectations."[156]

For this purpose, the PSCI created the Pharmaceutical Industry Principles for Responsible Supply Chain Management (the Principles), to articulate what the industry expects from the supply chain. An Implementation Guidance clarifies the Principles in each of the five areas (see words in italic in the previous paragraph), provides a framework for improvement, and gives examples of how to meet the PSCI expectations.

The PSCI has developed guidance tools tailored for companies working in the supply chain for assessing performance and risks. Furthermore, it hosts supplier conferences, webinars, and provides training materials through its freely available resource library[157]. 2016, 21 pharmaceutical and healthcare companies were members of the PSCI.

Homepage: https://pscinitiative.org

7.4.2 Electronics Industry Citizenship Coalition (EICC)

The electronics industry is a downstream user of the chemical industry, e.g. specialty chemicals and materials used in integrated circuits and devices, flat panel displays and light-emitting diodes.

"The EICC promotes an industry code of conduct and shared implementation resources for global electronics supply chains to improve working and environmental conditions. The EICC conducts joint audits, provides tools to audit compliance with the code, offers resources for training for procurement and suppliers, and helps companies report progress.

EICC membership is available to electronic manufacturers, software firms, ICT firms and manufacturing service providers, including contracted firms that design, manufacture or provide electronic goods, and as such covers the vast majority of the electronics supply chain."

Within its Code of Conduct, EICC refers to environmental standards and here to hazardous substances: "Chemicals and other materials posing a hazard if released to the environment are to be identified and managed to ensure their safe handling, movement, storage, use, recycling or reuse and disposal."

Homepage: http://www.eiccoalition.org

7.5 Interim conclusion from upstream/downstream value chain approaches

The selected examples are concerned with the use of hazardous chemicals in the textile value chain and with sustainable products. There is no common understanding of sustainable chemistry. Only ZDHC provides a definition, which refers to the German Environmental Agency and SusChem and includes government policy, socio-economic issues, resource efficiency, product stewardship, and use of efficient, effective, safe and more environmentally benign chemical products and processes (i.e. green chemistry). For implementation, ZDHC uses a Manufacturing Restricted Substances List. This MRSL refers to hazardous chemicals, an aspect of green chemistry. ZDHC lists no criteria for other sustainability aspects that are of concern in the entire textile value chain (e.g. occupational safety, human rights, forced and child labour).

Clean Production Action has developed Principles for Sustainable Plastics: Sustainable resources, closed loop systems, energy efficient and renewable, safer chemicals, healthy workplaces and communities. Based on these principles, CPA has introduced the Plastics Scorecard v1.0 for measuring pro-

[156] https://pscinitiative.org/about

[157] https://pscinitiative.org/resources

gress towards Safer Chemicals in Polymer Manufacturing. This Scorecard v1.0 only deals with one – but of course important – aspect of green chemistry: Hazardous chemicals (Chemicals of High Concern, CoHC). A description of how the other principles are realized (and how to deal with contradictions) is not available. For example, the feedstock question (fossil/non-fossil) is not included. Concerning additives, there are knowledge gaps, as relevant data for the various additive chemistries are often not available publicly.

According to the Lowell Center, "sustainable products" minimize environmental and social costs throughout the product life cycle, maximize environmental and social benefits to communities and remain economically viable. The Lowell Center proposes a Framework for Sustainable Products with a set of detailed criteria, e.g. "Product is energy, water, and materials efficient in production and use." But there are no metrics proposed for measuring or comparing the "sustainability" of products.

Overall, it can be concluded that the examples illustrate a key problem of sustainable chemistry: The lack of a set of appropriate (and commonly accepted) metrics for measuring sustainability performance.

8 Approaches at company level

In this chapter, the sustainability approaches of selected chemical companies are presented. Selection criteria include, amongst others, the country/region (as many regions as possible), the availability of information and the individuality of the approach. A long list in the appendix shows the pool of interesting approaches at company level.

8.1 Europe

8.1.1 AkzoNobel, Netherlands

8.1.1.1 Sustainability approach

AkzoNobel is the Dow Jones Sustainability World Index (DJSI World) Sustainability Leader 2016 (best in the Gold Class) in the chemicals sector (see Table 76 on page 187). Table 45 provides an overview of the company and its sustainability approach, mainly based on its Integrated Report 2015.[158]

Table 45: AkzoNobel: Short Characterization

Subject	Information
Name/title	Akzo Nobel N.V.
URL(s)	https://www.akzonobel.com
Country (head office)	Netherlands
Branches	Around 80 countries
Products, market	"As a leading global paints and coatings company and a major producer of specialty chemicals, we supply essential ingredients, essential protection and essential colour to industries and consumers worldwide." https://www.akzonobel.com/cs/aboutus/
Economic KPIs	€14.9 billion revenue €2.1 billion EBITDA
Employees	Approximately 45,000
Ratings	Dow Jones Sustainability World Index (DJSI World) Sustainability Leader 2016 in the chemicals sector; 2015 constituent in the following indices: FTSE4Good Index Series, Euronext Vigeo – World 120 index, STOXX® Global ESG Leaders indices, MSCI Global Sustainability Index Series, Ethibel Sustainability Index (ESI) Excellence Europe and the Ethibel Sustainability Index (ESI) Excellence Global.
Mission	"We create everyday essentials to make people's lives more liveable and inspiring."https://www.akzonobel.com/home
Principles/values	Safety, Integrity and Sustainability
Strategy	"Planet Possible approach to sustainability: "By doing radically more with less and working closely with customers and suppliers in our key end-user segments (Buildings and Infrastructure, Transportation, Consumer Goods, Industrial), we can help to make life more affordable,

[158] AkzoNobel: Report 2015. http://report.akzonobel.com/2015/ar/servicepages/downloads/files/akzonobel_report15_entire.pdf

Subject	Information
	colorful, healthy and comfortable for the world's ever-growing population." "[159]
CSR Report	2015, GRI G4, in accordance, core, integrated
Definition of sustainability OR sustainable chemistry	"We believe that the only way to be successful in the future is to care about the future. So for us, sustainability is also about many other things, such as investing in science to accelerate new ideas; investing in our capabilities to ensure we deliver for our customers on time, every time; and creating a sustainable business for shareholders. No definition of sustainable chemistry."[158]
Concept of selected indicators	GRI-oriented, including LCA approach, additional metrics such as eco-premium solutions with downstream benefits
Launch year, change in concept (if any) since then	In 2013, AkzoNobel announced a new vision, three-year targets, core principles and values, and strategy. [158]
Instruments and measures for implementation	Improvement plans and programmes, incentives and others.
Status of implementation (e.g. description of best practice etc.)	Different examples for eco-premium solutions with downstream benefits can be regarded as best practice, provided they are based on full LCAs.[160]
Status and type of monitoring including e.g. time series of indicator measurements	**Reporting**: Sites report data quarterly into the global HSE reporting system.The quarterly HSE report, including product aspects, is reviewed by the Executive Committee, the Sustainability Council and HSE management groups. **Internal Audit**: There are audits at a number of levels. … **External Audit**: Many sites have external certification to ISO 14001 or local Responsible Care standards **Benchmarking**: "We benchmark our performance against our peers using external benchmarks, e.g. DJSI, participation in cross business networks/ discussions, report reviews." [161]
Stakeholder engagement	**GRI G4-24, 26, 27 Stakeholder engagement**: Very detailed description of processes approach for different stakeholders (employees, suppliers, customers, investors & shareholders, NGOs and international organizations, governments and regulatory bodies, industrial associations, sustainability rating agencies, communities) [161] AkzoNobel is member/partner of (amongst others): ► Global Alliance to Eliminate Lead Paint (GAELP) ► Forest Stewardship Council (FSC) from 2010 to 2015 ► Sustainable Trade Initiative on Pulp & Paper (STIPP) – a sector-wide initiative co-founded by IDH, APP and AkzoNobel and supported by the Indonesian Ministry of Forestry and the Indonesia Pulp & Paper Association ► Together for Sustainability (TfS)
Additional information	AkzoNobel has developed the "four-dimensional profit and loss (**4D P&L**) methodology representing value creation in multiple dimensions.

[159] AkzoNobel: A quick guide to our sustainability strategy. http://794eb91f3e18f42a5aba-04d4ab5ee8af47c206891742c8ac8295.r81.cf3.rackcdn.com/akzonobel_planet_possible_quick_guide_tcm9-92474.pdf

Subject	Information
	"The 4D P&L methodology represents value creation in multiple dimensions. This is a new way of looking at an economy, where the role of a company in society at large can be assessed. The results add new sustainability perspectives to traditional risk/opportunity processes used in business decision-making. Thanks to this more extensive assessment, we can continue to engage with value chain partners and tackle specific actions that help us to reduce the negatives and build on the positives." [158]

Own compilation, using the following sources: AkzoNobel: Report 2015, and AkzoNobel: A quick guide to our sustainability strategy.
http://report.akzonobel.com/2015/ar/servicepages/downloads/files/akzonobel_report15_entire.pdf
http://794eb91f3e18f42a5aba-04d4ab5ee8af47c206891742c8ac8295.r81.cf3.rackcdn.com/akzonobel_planet_possible_quick_guide_tcm9-92474.pdf

AkzoNobel has published an integrated report in accordance with GRI G4 and therefore follows the triple bottom line approach (economic, environmental and social). The company offers neither a definition of sustainable chemistry nor an explicit definition of sustainability. Its commitment is "Doing more with less and creating more value from fewer resources."

AkzoNobel has the following strategic focus: "Our sustainability agenda incorporates economic, environmental and social aspects across the value chain. The importance of sustainability to running our business is firmly integrated into the AkzoNobel strategy. As well as being a strategic focus area, it is one of the three **core principles (Safety, Integrity and Sustainability)** that provide the foundation for our company values and the updated Code of Conduct. In addition, sustainability is being embedded into our company-wide processes, including Innovation, Commercial excellence and Talent management. Sustainability helps us to enhance our existing business, create new business opportunities and minimize risks. …

Our strategy has three sustainability focus areas designed to deliver more value from fewer resources, with targets for 2020. Our progress towards creating more value from fewer resources is measured by a special **Resource Efficiency Index (REI)**, which monitors the gross margin generated divided by the resource/energy use across the value chain (measured as **cradle-to-grave carbon footprint**). We focus on three aspects:

- **Sustainable business**: Creating business value through products and solutions that provide both functionality and other sustainability benefits, as well as cost savings from operational efficiencies. Target: 20 percent of revenue from eco-premium solutions with a downstream benefit by 2020
- **Resource efficiency**: Accelerating material and energy efficiency across the value chain. Target: 25-30 percent reduction in cradle-to-grave carbon footprint per ton of sales from 2012 to 2020
- **Capable, engaged people**: Engaging our people and partnering with our suppliers and customers to deliver significant changes. Objectives are emerging at Business Area and functional level

Sustainability foundations

These strategic objectives are underpinned by strong foundation programs for other economic, environmental and social aspects that are material for our business. Specifically, these are: people and process safety, product safety/stewardship, employee talent management/ engagement, community involvement, environmental management and integrity management. Community involvement is included due to the link to employee engagement. For these elements, we have key performance indica-

tors with 2015 targets, being extended to 2020. Other short-term and long-term ambitions are set at functional and business level." [158]

8.1.1.2 Criteria

Measuring sustainability progress

AkzoNobel has selected 14 criteria (metrics) for measuring its sustainability progress, most of them with defined targets (Table 46). Most of these criteria are not specific to the chemical industry and can thus be found in other sectors.

Table 46: AkzoNobel: Consolidated Sustainability Statements, 2015

Focus area	Metrics	Status 2015	Ambition 2015	Ambition 2020
Sustainable business	Resource Efficiency Index (REI)	113	–	–
	Eco-premium solutions with downstream benefits (% of revenue)	19	–	20
	Eco-premium solutions (% of revenue)	24	30	–
Resource efficiency	Carbon footprint cradle-to-grave per ton of product sales (% reduction from 2012)	3	–	25–30
	Renewable energy in own operations (%)	38	–	45
	Renewable raw materials (% of organic)	11	–	–
Capable, dedicated people	Employee engagement (ViewPoint score 1–5 scale)	4.03	>4.00	>4.20
Sustainability foundations	Total reportable injury rate employees / supervised contractors (per million hours)	1.6	<2.0	<1.0
	Significant loss of containment (Level D) *[Main indicator of process safety performance at its manufacturing sites]*	0	0	0
	Priority substances with management plan (%)	100	100	1001
	REACH compliance third phase (%) *[Preparation of information required for successful registration of substances that are under the scope of the third phase of the EU REACH regulations. All applications for registration must be submitted by June 2018.]*	23	25	100
	% of female executives	19	20	25
	% of executives from high growth markets	16	20	22
	Operational eco-efficiency footprint measure (% reduction from 2009)	23	30	40 (2017)

Own compilation, using the following source: AkzoNobel: Report 2015.
http://report.akzonobel.com/2015/ar/servicepages/downloads/files/akzonobel_report15_entire.pdf

Eco-premium solutions (EPS)

According to AkzoNobel's definition, eco-premium solutions are products and processes that offer an improvement in sustainability, delivering either environmental or social benefits. Eco-premium solutions with downstream benefits are those which provide customers and consumers in the downstream value chain with a significant sustainability advantage compared with the most commonly available equivalent commercial products or industrial processes.

EPS are measured via a quantitative analysis or a qualitative assessment of performance in seven categories:

- Energy efficiency
- Use of natural resources/raw materials
- Land use
- Emissions and waste
- Risks (e.g. accidents)
- Toxicity
- Health and well-being

"Recent examples of eco-premium solutions with downstream benefits include:[160] …

- Armohib CI-5150: A high-end film-forming corrosion inhibitor fulfilling the highest level of environmental criteria within the oilfield chemicals sector globally. Corrosion is a serious issue in the production and transportation of oil and gas which, without protective measures taken, could lead to serious consequences for health, safety and environment, not to mention the economic losses. Armohib CI-5150 is ten to 100 times less aquatoxic than the two globally most used competitive chemistry classes.
- Bolikel XP: A novel, highly efficient micronutrient for a full, healthy color of crop. It is fully biodegradable and water soluble, making this product suitable for sustainable soil applications (fertigation).
- Dulux Powerflexx: Unique Powerflexx technology and stay-clean properties mean that buildings are protected from peeling or flaking in any weather conditions and stay clean for longer. The Keep Cool technology of this external coating can reduce exterior temperatures by as much as 5 °C, keeping homes cooler and reducing energy use for cooling in warmer climates.
- Sikkens Cetol BLX-Pro Top: A waterborne woodcare product with stay-clean properties. These extend the lifetime. Compared with the regular recipe, this product has a lower carbon footprint. It is sold mainly in Germany and France, and is being introduced in Belgium, Spain and Italy.
- Kayabrid: A coupling agent between polar fillers and non-polar polymer chains, allowing commodity plastics such as polypropylene to be processed into high performance composites. Lower loadings of coupling agent are needed to achieve the same/higher mechanical properties. The carbon footprint is low due to the use of bio-based fibers."

Carbon footprint cradle-to-grave

"Lifecycle thinking is the basis for all our sustainability work. Our standard assessment method is eco-efficiency analysis (EEA), based on a combination of lifecycle assessments and lifecycle costing. Assessment work is carried out by business and company level specialists and is based on ISO 14040-44 and a company lifecycle assessment database. …

[160] This is a statement by AkzoNobel. Its standard assessment method is eco-efficiency analysis (EEA), based on a combination of life cycle assessments and life cycle costing. Nevertheless, the authors have no knowledge of scientific assessments / LCAs for the precise assessment of sustainability.

We measure the carbon footprint of all our key value chains (472 in 2015) using a full cradle-to-grave, or screening, lifecycle assessment. This is the basis of our carbon footprint key performance indicator."

Cradle-to-grave is the full Life Cycle Assessment starting at resource extraction ('cradle'), including own and customer operations, the end-user and end-of-life ('grave').

Priority substances with management plan

"Our company-wide priority substance process takes a systematic approach to the identification, review and management of hazardous substances that we use in our products and chemical processes. Taking this proactive approach promotes the use of safer and sustainable products and means we often take action to manage harmful substances in advance of legislation, future-proofing our products against changes in regulations. The process identifies hazardous substances for review by scoring them on the basis of their human and environmental hazards and where societal concern exists over their use. Substances with higher scores are designated as priority substances and are subject to review by our experts. Where a safer and effective alternative exists (which is economically feasible), priority substances are substituted with less hazardous materials. In cases where substitution is not possible, a full risk assessment is carried out on the substance using state-of-the-art techniques from the EU REACH regulations.

Only when use of a priority substance can be managed safely can it be used in AkzoNobel products and processes.

The process is supported by a mandatory company rule, which lists priority substances that are either prohibited or restricted in AkzoNobel products and/or processes.

- Review and management of 204 priority substances used in AkzoNobel have been completed, meeting our ambition for 2015
- Of the priority substances reviewed in the program, 56 have been phased out and 148 restricted to uses where the risk can be managed to an acceptable level
- Examples of priority substances that were reviewed and restricted in 2015 are methyl ethyl ketoxime (MEKO) and triisopropyl borate. These substances must not exceed maximum levels in AkzoNobel products and strict risk management measures must be followed when they are used.
- We presented our priority substances program to stakeholders including customers, non-governmental organizations and investor associations and received positive feedback on our approach.

The priority substance methodology is now embedded into key business processes and in our company raw material databases, so safer materials can be sourced in AkzoNobel. We are now developing the second phase of the priority substance program, which will update the scoring methodology and take into account new information and concerns on hazardous substances.

In 2015, AkzoNobel received the Responsible Care® Product Stewardship Award from the European Chemicals Industry Association (Cefic) for its priority substances program. In addition, we were awarded a Product Safety award from the American Chemistry Council (ACC) and a merit award for Responsible Care® from the Association of International Chemical Manufacturers (AICM) in China."

8.1.1.3 Organizational structure and implementation

Sustainability is integrated in management processes. "The management structure for sustainability includes corporate and business elements. There is a central Sustainability and HSE expertise group as well as business resource: [161]

- The **Executive Committee** has overall responsibility for all Sustainability aspects.
- Andre Veneman, Corporate Director, HSE and Sustainability reports to the CEO and to the Head of Supply Chain and Development for environmental issues.
- **Sustainability Council** reviews performance and initiates new developments for all sustainability aspects (cross function AkzoNobel and business representatives)
- **Sustainability leadership team** reviews performance and develops the company sustainability agenda (central and business representatives)
- **Sustainability Centre of expertise**: sustainability analysis, new developments, reporting standards
- **Central legal legacy expertise group**: soil and groundwater protection, environmental engineers
- **Sustainability managers network** shares good practice to accelerate improvement across business areas (central and business representatives)
- Site based environmental activities are coordinated by **business/site operations managers**
- Business structure:
  - Business Sustainability director/ management team member
  - Business Sustainability manager
  - Business and Site HSE/operations manager

Sustainability performance is supported e.g. by improvement plans and programs and incentives: [162]

"We strive to empower all employees to contribute and be accountable for our sustainability performance, using training and other engagement processes, including business and site level activity, as well as web-based resources. This responsibility continues to be anchored in the personal targets and remuneration packages of managers and employees. **Thirty percent of the conditional grant of shares for Board of Management members and all executives is based on AkzoNobel's performance in the RobecoSAM assessment over a three-year period** (see Remuneration report in the Governance and compliance section). This link to sustainability performance has been in place since 2009."

8.1.1.4 Evaluation

With regard to its sustainability approach and the integration of sustainability into its corporate strategy, AkzoNobel is a leading company. Though AkzoNobel provides no explicit definition of sustainable chemistry, it proves that its understanding of sustainability follows the triplebottom line approach (material economic, environmental or social impacts). This is supported by the metrics for measuring sustainability progress, see Table 46, which includes, for example, resource efficiency parameters such as Resource Efficiency Index (REI), eco-premium solutions, carbon footprint, use of renewable energy and renewable raw materials. These or comparable metrics are globally applicable to chemical companies. Most of these criteria are not specific to the chemical industry and can thus be found in other sectors.

[161] AkzoNobel G4 indicators – Additional information to the Report 2015. https://a96fa647e5e0932a529c-f3023a2080eb9170df7c92d8b2a39df1.ssl.cf3.rackcdn.com/gri-additional-information-to-the-an-report-2015-v2.pdf

[162] Report 2015 pp. 198 et seq.

The indicator concept is consistent with the company's approach. Monitoring is effected through AkzoNobel's Annual Report and its additional Report on G4 indicators (option "core", see section 9.1.1.3).

AkzoNobel has examined the relevance of the SDGs for its strategy: "In 2014, we were one of more than 60 signatories of their Post-2015 Charter, committing to contribute to the achievement of the United Nations Sustainable Development Goals (2015-2030). We have reviewed these goals against our company agenda and priorities. Our Human Cities agenda will lead to a focus on Goal 11 Sustainable cities and communities, and Goal 17 Partnerships for the goals, extending existing and developing new programs or partnerships …" [158]

Table 47 provides an overview of the main criteria for the evaluation of the company's sustainability approach.

Table 47: AkzoNobel: Evaluation of sustainability approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of sustainable chemistry, but sustainability is understood within the concept of the triplebottom line (material[163] economic, environmental or social impacts). Globally applicable to chemical companies.
Consistency of indicator concept and how it is monitored	Indicator concept is consistent with the company's approach. Monitoring is done through the company's Annual Report and its additional report on GRI G4 indicators.
Role of SDGs in the concept	Not regarded as a driver, but as a task that is fulfilled. Focus is laid on two of the SDGs (11 and 17).
Probability of implementation	Implemented.
Overall impression	Frontrunner.

Source: Own compilation

8.1.2 Koninklijke DSM NV, Netherlands

8.1.2.1 Sustainability approach

DSM is rated by RobecoSAM as Gold Class and is second best behind AkzoNobel, the Dow Jones Sustainability World Index (DJSI World) Sustainability Leader 2016 in the chemicals sector (see Table 76 on page 186). Table 48 provides an overview of the company and its sustainability approach, mainly based on its Factbook 2016[164] and its company presentation[165].

Table 48: DSM: Short Characterization 2015

Subject	Information
Name/title	Koninklijke DSM NV
URL(s)	http://www.dsm.com
Country (head office)	Netherlands
Branches	> 50 countries, most of them in America (North and South), Europe and Asia

[163] Definition og „mateiality" by GRI see footnote 1

[164] http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/factbook-2016.pdf

[165] http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/company-presentation.pdf

Subject	Information
Products, market	"Royal DSM is a global science-based company active in health, nutrition and materials. … DSM delivers innovative solutions that nourish, protect and improve performance in global markets such as food and dietary supplements, personal care, feed, medical devices, automotive, paints, electrical and electronics, life protection[166], alternative energy and bio-based materials." http://www.dsm.com/corporate/about/our-company.html
Economic KPIs	€7.722 billion revenue, €1.075 billion EBITDA
Employees	20,750
Ratings	Dow Jones Sustainability World Index (DJSI World) Gold Class member 2016 in the chemicals sector; 2015 DSM was featured in the following indices: FTSE4 Good Index Series, Euronext Vigeo – World 120 Index, STOXX® Global ESG Leaders indices, MSCI Europe Mid Cap Value Index, Ethibel Sustainability Index (ESI) Excellence Europe.
Mission	"Our purpose is to create brighter lives for people today and generations to come." http://www.dsm.com/corporate/about/our-company/who-we-are.html
Principles/values	"We respect **One DSM** every day through our behavior: we focus on customers; we drive for results; we improve, innovate and change; we engage with people; and we act responsibly."[167]
Strategy	"Our corporate strategy is … focused on addressing key global needs such as alternative energies, climate change and health and nutrition for all."[167] Strategy 2018: Driving Profitable Growth through science-based, sustainable solutions [168] Three dimensional value generation: People – Planet – Profit. People+: Product solutions creating measurable better impact on people's live than competing alternatives ECO+: Product solutions creating more value with less environmental impact than competing alternatives
CSR-Report	2015, GRI G4, in accordance, comprehensive, integrated
Definition of sustainability OR sustainable chemistry	**No definition of sustainable chemistry.** "To us, achieving sustainability means simultaneously pursuing economic performance, environmental quality and social responsibility, in other words creating value on the three dimensions of People, Planet and Profit."[169]
Concept of selected indicators	GRI-oriented, including LCA approach, additional metrics such as Eco+ and People+ solutions with downstream benefits
Launch year, change in concept (if any) since then	2015: "We have furthermore sharpened our sustainability approach and set more ambitious targets for our environmental performance. These include further improved greenhouse-gas efficiency (at least 45%

[166] Protective vests, helmets and vehicles. http://www.dsm.com/corporate/markets-products/markets/life-protection.html

[167] One DSM – Code of business conduct for DSM employees. September 2010. http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/code-of-business-conduct-for-dsm-employees.pdf

[168] http://annualreport.dsm.com/ar2015/en_US/section-557009.html

[169] http://www.dsm.com/corporate/about/corporate-governance/business-principles/our-core-value.html

Subject	Information
	improvement by 2025 versus 20% achieved so far), increased energy efficiency (over 10% improvement in the next 10 years) and a big step-up in the use of renewable electricity (50% by 2025), as well as continuing to drive the proportion of ECO+ and People+ solutions we provide to our customers." [175]
Instruments and measures for implementation	Plans and programmes, incentives.
Status of implementation (e.g. description of best practice etc.)	Different examples for Eco+ or People+ solutions with downstream benefits can be regarded as best practice.
Status and type of monitoring including e.g. time series of indicator measurements	**Reporting**: "As sustainability is at the core of DSM's strategy, the company reports on the progress of its sustainability targets in an integrated way with its financial targets, every quarter. DSM's reporting of its sustainability performance in its Integrated Annual Report is externally audited through limited assurance processes each year."[170] **Internal Audit**: "DSM's Corporate Operational Audit department conducts regular sustainability audits as a part of the company's Corporate Risk Management activities (sometimes unannounced). Increasingly, these audits aren't focused purely on DSM but also apply to various partners and suppliers in the value chain." [170] **External Audit**: "We run a **Global Management System** at all sites worldwide based on international standard **ISO 14001**:2004."[171] (Applies only to DSM Engineering Plastics)
Stakeholder engagement	"DSM's current strategy, Driving Profitable Growth, was based on extensive study and consultations within the company, as well as with key stakeholders beyond the company's value chains. … DSM's associations and networks, as well as contacts with the United Nations and NGOs, are key to DSM effectively engaging with stakeholders and our scientists, executives and Managing Board members hold positions in numerous, wide-ranging organizations."[172] DSM is member/partner of (amongst others): ► The Sustainability Consortium ► Together for Sustainability ► United Nations Global Compact ► World Business Council on Sustainable Development (WBCSD) ► UN Women's Empowerment Principles (WEP) ► The World Economic Forum (WEF) ► CBCSD (China Business Council on Sustainable Development) ► CEFIC (The European Chemical Industry Council)

[170] http://www.dsm.com/corporate/sustainability/managing-sustainability/governance.html

[171] http://www.dsm.com/corporate/about/business-entities/dsm-engineering-plastics/dsm-engineering-plastics-quality.html

[172] http://www.dsm.com/corporate/sustainability/managing-sustainability/stakeholder-engagement.html

Subject	Information
Additional information	In 2015, DSM received several awards and other forms of recognition from non-governmental and trade organizations, customers, suppliers and the academic world: ► "In June 2015, DSM received AICM's Responsible Care Award with nine peers. AICM is an initiative with an aspiration to stimulate sustainability in China's chemical industry, as well as to support communities affected by the sector's operations. ► In August 2015, the Carbon Disclosure Project (CDP) reviewed 18 chemical corporations with a combined market capitalization of over USD 500 billion in seven categories with regards to environmental protection policies. With an A grade in three of the seven categories, DSM ranked second following DuPont. DSM also received the highest obtainable grade for carbon regulation readiness. ► In November 2015, DSM was recognized as Overall Winner of the Singapore Sustainable Business Awards and also won awards in Supply Chain Management and Climate Change."[173]

Own compilation, using the following sources from Royal DSM: Factbook 2016, Company Presentation and Integrated Annual Report 2015. http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/factbook-2016.pdf http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/company-presentation.pdf http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/dsm-integrated-annual-report-2015.pdf

DSM has published an integrated report in accordance with GRI G4. The company offers neither a definition of sustainable chemistry nor an explicit definition of sustainability. However it follows the triple bottom line approach (economic, environmental and social), in DSM's words: Human, environmental and economic or "the triple bottom line of People, Planet and Profit". [174]

DSM has the following vision and strategy:

"At DSM sustainability is the core value of the company. We are focused on delivering science-based, sustainable and scalable solutions that face up to the challenges our world faces today. …

Our products & environmental performance

We measure the environmental and social impact of our products at both a production level and over their full life cycle, from resource extraction to waste management. Insights from these studies show us where we can further improve and where to target our **Bright Science** so we constantly improve the sustainability performance of our customers or end users.

Brighter Living Solutions

DSM's **ECO+ solutions** are so-called because they are measurably better than the mainstream solution on the market in terms of their environmental impact (i.e. CO_2 emissions, resource extraction, waste etc.). **People+ solutions** on the other hand measure our products social impact based on criteria such as working conditions and health. Combined these are called **Brighter Living solutions**, and currently they account for 60% of DSM's product portfolio.

[173] Royal DSM Integrated Annual Report 2015. http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/dsm-integrated-annual-report-2015.pdf

[174] http://www.dsm.com/corporate/about/corporate-governance/business-principles.html

Global Megatrends

A number of global societal trends are affecting people, economies and markets, largely driven by demographic change. The world's population continues to grow to an estimated nine billion in 2050. We're living longer and in the main we're becoming increasingly wealthy and urbanized. This will further increase the pressure on the planet's resources that we rely on for food, materials and energy.

Business for society

DSM believes companies have an increasingly important responsibility to address these challenges together with governments, fellow companies, civil society organizations like NGOs, and consumers. The UN Sustainable Development Goals are a good example of this sort of multi-stakeholder initiative setting a common priority agenda to change old-unsustainable practices.

Sustainable Growth Platforms

DSM has identified three key areas in which we can drive sustainable markets:

- Nutrition http://www.dsm.com/corporate/sustainability/nutrition.html
- Climate Change http://www.dsm.com/corporate/sustainability/climate-change.html
- Circular Economy http://www.dsm.com/corporate/sustainability/circular-economy.html

Innovations in these Sustainable Growth Platforms secure our position as a company providing solutions for urgent societal challenges."

8.1.2.2 Criteria

Measuring sustainability progress

DSM has selected ten criteria (metrics) for measuring its sustainability progress, most of them with defined targets (Table 49). Nearly all these criteria are not specific to the chemical industry and can thus be found in other sectors. ECO+ and People+ (from 2016 on "Brighter Living Solutions") are specific for this company, but comparable e.g. to AkzoNobel's eco-premium solutions (see page 123).

Table 49: DSM: Sustainability aspirations 2011-2015 and ambitions 2020 [175]

Focus area	Metrics	Status 2015	Ambition 2015	Ambition 2020 (2025)
Dow Jones Sustainability Index	Top ranking (RobecoSAM Gold Class)	Silver Class[1]	Gold Class	Gold Class
ECO+ (innovation)	% of pipeline is ECO+[2]	91%	80% minimum	Not specified
ECO+ (running business)	% of DSM's product portfolio, starting from approximately 34%	57%	50%	See Brighter Living Solutions
Energy efficiency	% improvement in 2020 compared to 2008	19%	20%	>10% (2025)[4]
Greenhouse gas emissions	% reduction (absolute) by 2020 compared to 2008	75% reduction[3]	25% (absolute)	45% (2025)[5]
Use of renewable energy	% of used energy	-	-	50% (2025)[6]
Employee Engagement Survey	Towards High Performance Norm (% favorable)[7]	69%	>80%	Towards 75%

Focus area	Metrics	Status 2015	Ambition 2015	Ambition 2020 (2025)
Diversity[8]	Women in executive positions (2015) / Female executives (2020)	15%	Not specified	25%
	Under-represented nationalities in executive positions (2015) / Executives from under-represented nationalities (2020)	49%	Not specified	60%
People+[8]	DSM People LCA	Achieved	Not specified	Not specified
Brighter Living Solutions ECO+/People+ (running business)	% of DSM's product portfolio	60%	-	65%
Safety[9]	Frequency Index Recordables, starting with 0.57 in 2010	0.41	Not specified	0.25

1 DSM has returned to Gold Class for 2016
2 See ECO+ for a definition of ECO+
3 Reduction of total emissions (absolute) of 75% was mainly attributable to the deconsolidation of DSM Fibre Intermediates; the GHG efficiency, which accounts for changes in production volume, has improved by 20% in 2015 compared to 2008
4 Letter from the CEO: Over 10% improvement in the next 10 years (i.e. base year = 2015)
5 Letter from the CEO: At least 45% improvement by 2025 versus 20% achieved so far (i.e. base year = 2015)
6 Letter from the CEO: "a big step-up in the use of renewable electricity (50% by 2025)"
7 The High Performance Norm (over 80% favourable) is the composite of the top 25% employee responses of the selected external benchmark organizations
8 See 'People+' and 'Inclusion & Diversity' in the chapter 'People' in 2015 on People in 2015 and ECO+ for a definition of People+
9 DSM aims to reduce its Frequency Index of Recordable Injuries by 50% or more by the year 2020 compared to 2010, meaning an index score that is less than or equal to 0.25 in 2020, compared to the 0.57 achieved in 2010. This Frequency Index is based on the number of fatalities, lost or restricted workday cases or medical treatment cases per 100 DSM employees and contractors in one year. http://www.dsm.com/corporate/sustainability/our-operations/our-employees.html
Own compilation, using the following source: Royal DSM Integrated Annual Report 2015.
http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/dsm-integrated-annual-report-2015.pdf

As mentioned above, from 2016 onwards, DSM will refer to ECO+ and People+ as Brighter Living Solutions. These are products and services that, when considered over their whole life cycle, offer a clear environmental benefit (ECO+) and/or a social benefit (People+) compared to competing mainstream products, that fulfil the same function, or competing mainstream reference solutions. [175]

Brighter Living Solutions

"DSM's Brighter Living Solutions are profitable products and innovations that have a measurably better impact on planet (ECO+) and people (People+) than mainstream competitors.

A product life cycle approach is used to determine if products and innovations are Brighter Living Solutions. This evaluates the product life cycle from raw material extraction, via production, manufactur-

[175] Royal DSM Integrated Annual Report 2015.
http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/dsm-integrated-annual-report-2015.pdf

ing, transport and use, all the way to end of life and recycling. Environmental and social differentiators can be created in all stages of the product life cycle. …

Examples of drivers that support the development of **Brighter Living Solutions** include:

- Resources: efficient use, use of waste streams, avoiding scarce materials
- Land use: higher yield with same land, use of waste streams
- Water: more efficient, reducing water waste
- Energy: energy efficiency, application of renewable energy
- Emissions: reduced or avoided greenhouse gas emissions, small air particles
- Health condition: improved health condition of end users, risk reduction of diseases
- Comfort and wellbeing: improved perceived comfort & wellbeing, reduced noise, smell
- Working conditions: improved working conditions, health and safety, fair wages, equal opportunities
- Community development: job creation in the regions, improved infrastructure, education"

Examples of **ECO+ solutions**[176] in materials and nutrition are:[177]

- **Stanyl® TC** lowers system costs and reduces carbon footprint: "By selecting Stanyl TC, Osram was able to reduce the weight of the housing by around 50% and shrink production cycle times, resulting in lower system cost and high volume production. It also significantly reduces the carbon footprint associated with the production of LED lamps as heat sinks made from Stanyl TC involve CO_2 emissions that are 85% lower than in the production of cast aluminum heat sinks."
- **Dyneema®**: Lightweight, stronger and more durable cargo nets reduce aviation emissions: "Together with our partners the Air France-KLM Group, one of the world's largest airlines and AmSafe Bridport, the world leader in aviation restraint technology, DSM developed a cargo pallet net (the means by which cargo is secured to a pallet, which in turn is secured to the aircraft deck during transit) made with DSM's Dyneema® the World's Strongest Fiber™. Each net weighs only 9 kg, half the weight of a conventional net. This equates to a fuel saving of 210 gallons (795 liters) of aviation fuel per year and a reduction in CO_2 emissions of over 2.5 tonnes (2,500 kg) each year."

Examples of **People+ solutions**[176] in materials and nutrition are:[178]

- **Decovery®**, a revolution in sustainable paint. "Consequently reducing exposure to VOCs has driven innovation in water-based paint and coating technology over the last 50 years, to the extent that 80% of paint sold to the residential market is now water-based. … Using a novel process of converting plant-based materials into a durable bio-based polymer, Decovery resins offer a renewable alternative to conventional binders."
- **Arnitel® VT**, a 100% barrier against fluids, bacteria and viruses. "Arnitel® VT is a very flexible and breathable material that, when made into membranes just a few microns thick, is 100% waterproof, highly breathable and very comfortable. … Gowns manufactured with the Arnitel VT technology finally provide the surgeon with 100% protection against viruses and bacteria without loss of comfort."

[176] This is a statement by DSM. The authors have no knowledge of scientific assessments / LCAs for the precise assessment of sustainability, since here only individual sustainability aspects are mentioned.

[177] http://www.dsm.com/corporate/sustainability/brighter-living-solutions/eco-plus/eco-plus-solutions.html

[178] http://www.dsm.com/corporate/sustainability/brighter-living-solutions/people-plus/people-plus-solutions.html

DSM Priority Substance List

"In the control of SVHCs, DSM has started to assess, before the end of 2020, all substances of which more than 1 ton per year is used in its processes to identify and monitor long-term human and environmental hazards. Identified SVHCs need to be reported in a DSM Priority Substance List and their use challenged by an internal justification process by a multidisciplinary team. The final goal is the phase-out of toxic substances, not only from DSM's own portfolio but from the full life cycle of its products, in line with the company's commitment to bringing more sustainable alternatives to the market. Where substitution is not currently possible, a risk assessment is performed following industry standard procedures. If safe use cannot be shown, the SVHC is prohibited from further use or production within DSM." [175]

Roundtable for Product Social Metrics

"DSM actively strives to create a harmonized and broadly accepted methodology together with the Roundtable for Product Social Metrics (http://product-social-impact-assessment.com) that was co-founded and consists of PréConsultants, Ahold, BASF, BMW Group, Goodyear, Philips, AkzoNobel, L'Oréal, and Marks & Spencer.

The Roundtable has published a **Handbook for Product Social Impact Assessment[179]**, a practical tool for sustainability professionals and a standardized objective methodology for assessing a products social impact."

"This handbook outlines an aligned method for social impact assessment at product level. The work of the Roundtable is based on the approaches of the participant companies and external references such as UNEP SETAC Guidelines for Social Life Cycle Assessment of Products (UNEP SETAC, 2009) and corporate level standards (GRI, 2013; ISO, 2010). Given the lack of global standards on methods for social impact assessment at product level, the Roundtable developed this method through gaining an understanding of and drawing upon the various methods already applied by the members of the Roundtable. In addition, guiding principles were defined for the development of this work. These include a focus on the practical feasibility for organisations to conduct product social impact assessment, using a consistent method and making efficient use of human and financial resources."[179]

8.1.2.3 Organizational structure and implementation

The structure at DSM follows the principle of lead from the top: [180]

- "As DSM's core value, Sustainability has the attention of the entire **Managing Board with CEO Feike Sijbesma** as the primary focal point. …
- The **Sustainability Leadership Team**, chaired by the Vice President Corporate Sustainability (who reports directly to the CEO) monitors the integration of sustainability into DSM's business groups via policies and processes and oversees DSM's sustainability performance and targets each quarter. Each of DSM's business groups are represented in this Leadership Team. …
- To support the company with developing, implementing, monitoring and reporting on its sustainability policies, DSM's Supervisory Board appointed its own **Sustainability Committee** in 2009 to supervise the Managing Board on sustainability matters. …
- DSM has also set up an **external Sustainability Advisory Board** – a diverse international group of thought leaders and sustainability practitioners – to help deepen its understanding of sustainability and understanding of external stakeholder needs. …

[179] http://product-social-impact-assessment.com/wp-content/uploads/2014/07/Handbook-for-Product-Social-Impact-Assessment-3.0.pdf

[180] http://www.dsm.com/corporate/sustainability/managing-sustainability/governance.html

- DSM's Corporate Operational Audit department conducts regular sustainability audits as a part of the company's Corporate Risk Management activities (sometimes unannounced). Increasingly, these audits aren't focused purely on DSM but also apply to various partners and suppliers in the value chain."

"As a mark of how seriously sustainability is taken at DSM, the company ties sustainability with financials – including **remuneration**. The remuneration of DSM's Managing Board is based on both short and long-term goals – stretching beyond purely financial targets. 50% of board member's compensation is a base salary. Half of that sum is based on **sustainability performance** – covering the proportion of products qualifying as Brighter Living Solutions, energy reduction and employee satisfaction and engagement. Variable income (bonuses) makes up the remaining 50% of salary, half of which is based solely on **progress in reducing DSM's greenhouse gas emissions**. This total compensation package is based on the average of a labor-market peer group, all of which is overseen by a remuneration committee." [180]

8.1.2.4 Evaluation

With regard to its sustainability approach and the integration of sustainability into its corporate strategy, DSM belongs to the frontrunners.

Though DSM provides no explicit definition of sustainable chemistry, it proves that its understanding of sustainability is comprehensive (economic performance, environmental quality and social responsibility). This is supported by the metrics for measuring sustainability progress, see Table 49, which include parameters such as ranking in the DJSI, products/solutions with downstream benefits (Eco+/People+), energy efficiency and diversity targets (female executives and executives from underrepresented nationalities (2020). These or comparable metrics are globally applicable to chemical companies. Most of these criteria are not specific to the chemical industry and can thus be found in other sectors.

The indicator concept is GRI-oriented, including LCA approach, additional metrics such as Eco+ and People+ solutions with downstream benefits; it is consistent with the company's approach. Monitoring is done through DSM's Integrated Annual Report.

DSM has examined the relevance of the SDGs for its strategy: "Societal Issues: The world agreed on Sustainable Development Goals (SDGs). DSM contributes to many of them, especially 2, 3, 7, 12, 13 and 17."[181]

Table 50 provides an overview of the main criteria for the evaluation of the company's sustainability approach.

Table 50: DSM: Evaluation of sustainability approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of sustainable chemistry, but sustainability follows the triplebottom line approach (economic performance, environmental quality and social responsibility). Globally applicable to chemical companies.
Consistency of indicator concept and how it is monitored	Indicator concept is consistent with the company's approach. Monitoring is done through the company's annual Integrated Report.

[181] DSM Sustainability Introduction. DSM Corporate Sustainability 2016. http://www.dsm.com/content/dam/dsm/cworld/en_US/documents/dsm-sustainability-introduction.pdf

Subject	Comment
Role of SDGs in the concept	Not regarded as a driver, but as a task that is fulfilled. Focus is laid on SDGs 2, 3, 7, 12, 13 and 17.
Probability of implementation	Implemented.
Overall impression	Frontrunner.

Source: Own compilation

8.2 North America

8.2.1 Dow Chemical

On 11 December 2015, DuPont and The Dow Chemical Company announced "that their boards of directors unanimously approved a definitive agreement under which the companies will combine in an all-stock merger of equals. The combined company will be named DowDuPont. The parties intend to subsequently pursue a separation of DowDuPont into three independent, publicly traded companies through tax-free spin-offs. This would occur as soon as feasible, which is expected to be 18-24 months following the closing of the merger, subject to regulatory and board approval." [182]

8.2.1.1 Sustainability approach

Dow Chemical is top of the Bronze Class in the chemicals sector as rated by RobecoSAM (see Table 76). Table 51 provides an overview of the company and its sustainability approach, mainly based on the Annual Report 2015[183] and the Sustainability Report 2015[184].

Table 51: Dow Chemical: Short Characterization

Subject	Information
Name/title	The Dow Chemical Company
URL(s)	www.dow.com
Country (head office)	Michigan, USA
Branches	179 sites in 35 countries
Products, market	> 6,000 product families "We serve the following industries: appliance; automotive; agricultural; building and construction; chemical processing; electronics; furniture; housewares; oil and gas; packaging; paints, coatings and adhesives; personal care; pharmaceutical; processed foods; pulp and paper; textile and carpet; utilities; and water treatment. We conduct worldwide operations through global businesses, which are reported in five operating segments: ► Agricultural Sciences ► Consumer Solutions ► Infrastructure Solutions ► Performance Materials and Chemicals ► Performance Plastics"[184]
Economic KPIs	$48.8 billion revenue $9.6 billion operating EBITDA

[182] http://www.dow.com/en-us/news/press-releases/dupont-and-dow-to-combine-in-merger-of-equals
[183] http://storage.dow.com.edgesuite.net/dow.com/investors/2015_Dow_Chemical_Annual_Report.pdf
[184] http://media-library.dow.com/WebContent/www-dow-com/Documents/Dow_2015_SustainabilityReport.pdf

Subject	Information
Employees	Approximately 49,500 people
Ratings	Dow Jones Sustainability World Index (DJSI World) 2016 Bronze Class in the chemicals sector
Mission	"Mission: To passionately create innovation for our stakeholders at the intersection of chemistry, biology and physics."[184]
Principles/values	"Integrity, Respect for People, Protecting Our Planet" [184]
Strategy	Dow's strategy is to "invest in a market-driven portfolio of advantaged and technology-enabled businesses that create value for our shareholders and customers." [184]
CSR-Report	2015, GRI G4, in accordance, comprehensive
Definition of sustainable chemistry	"With more than 95 percent of all manufactured goods relying on chemistry in their value chain, integrating sustainability and green chemistry concepts – "sustainable chemistry" – as a building block is a vitally important part of building a more sustainable economy. Green chemistry is a set of principles to design, but **sustainable chemistry** looks beyond only a science. It is a catalyst for change, an innovative approach to problem-solving and a long-term solution to global sustainability challenges. … Ultimately, chemistry and collaboration – and people – have the power to bend that straight line to a more positive point in the future, where nature and therefore human prosperity are in balance" [185] "Sustainable chemistry is our "cradle to cradle" concept that drives us to: ► Use resources more efficiently ► Minimize our footprint [1] ► Provide value to our customers and stakeholders ► Deliver solutions for customer needs ► Enhance the quality of life of current and future generations" [186]
Concept of selected indicators	2015: GRI-oriented, including LCA approach, additional metrics in Dow's Sustainable Chemistry Index (SCI) with (amongst others) social need; Breakthrough: Evaluation of innovations for their impact toward alleviating world challenges (energy and climate change, water, food, housing and health). 2025 Goals: Impact-oriented goals and measures, aiming at the transition to a sustainable planet and society. Apart from (classic) performance indicators, societal impact indicators are introduced: ► Measured level of support among key value chain and stakeholder representatives ► Sum of people whose sustainable development challenges have been positively impacted.
Launch year, change in concept (if any) since then	"In 2015 Dow announced a strategic set of commitments designed to redefine the role of business in society. Dow's 2025 Sustainability Goals

[185] Dave Kepler, Executive Vice President of Business Services and Chief Sustainability Officer & Chief Information Officer of The Dow Chemical Company: Dow's 4 pillars of sustainable chemistry and a green economy. Wednesday, May 16, 2012 – 3:40 AM. https://www.greenbiz.com/blog/2012/05/04/4-pillars-sustainable-chemistry-and-green-economy

[186] http://www.dow.com/en-us/science-and-sustainability/2025-sustainability-goals/sustainable-chemistry

Subject	Information
	use a global lens to magnify the Company's impact around the world, driving unprecedented collaborations to develop societal blueprints that will facilitate the transition to a sustainable planet and society." [184]
Instruments and measures for implementation	Incentives: Remuneration which includes performance on sustainability goals. Collaboration with organizations and institutions around the world (academics, industry, governments, NGOs) [187]
Status of implementation (e.g. description of best practice etc.)	Most of the 2015 goals have been reached. Sustainable Chemistry Index (SCI): No information on corresponding substances/products Breakthroughs: Can be regarded as best practice.
Status and type of monitoring including e.g. time series of indicator measurements	**Monitoring:** "We have been awarded a Gold Recognition Level in sustainability and CSR performance assessment conducted by EcoVadis for the second year in a row. EcoVadis is a collaborative platform enabling companies to monitor the sustainable performance of their suppliers. Dow demonstrated a comprehensive CRS management system that covered the following four themes: ► Environmental ► Labor Practices & Human Rights ► Fair Business Practices and ► Sustainable Procurement" [184] **Reporting**: Annual publication of Sustainability Report.
Stakeholder engagement	**GRI G4-24,25,27 Stakeholder engagement**: Very detailed description of process approach for different stakeholders (advisory groups, communities, employees, consortiums, academia, NGOs, potential job candidates). [184] More information available on the Corporate Citizenship website. [188] Dow Chemical is member/partner of (amongst others): ► Carbon Disclosure Project ► The Sustainability Consortium ► United Nations Global Compact ► World Business Council for Sustainable Development (WBCSD) ► World Resources Institute Corporate Consultative Group
Additional information	**"Dow One of the Most Recognized on OUTstanding Leading LGBT+ and Ally Executives and LGBT+ Future Leaders Lists** *Recognizing Dow's Thought Leadership and Action to Promote LGBT Inclusion* MIDLAND, Mich. – October 25, 2016 – In recognition of their efforts to champion lesbian, gay, bisexual and transgender (LGBT) equality in the workplace, six executives and leaders from The Dow Chemical Company (NYSE: DOW) have been named to the 2016 OUTstanding Leading LGBT+ & Ally Executives and LGBT+ Future Leaders Lists, published by the Financial Times. The rankings honor LGBT and ally leaders who actively contribute to an environment where all employees feel safe,

[187] http://www.dow.com/en-us/science-and-sustainability/collaborations

[188] http://www.dow.com/en-us/science-and-sustainability/global-citizenship

Subject	Information
	are respected and valued, and are able to bring their whole selves to work. Dow was one of the most recognized among all companies on this year's lists and all three executives in Dow's Office of the Chairman and CEO have been honored by OUTstanding, highlighting the Company's continued, high-level commitment to LGBT rights and equality."[189]

1 The Dow Chemical Sustainability Footprint Tool© is used widely in Dow's R&D and is publicly available to Dow customers. This tool considers all stages of the value chain to show if the successful commercialization of the project will lead to a more sustainable service being delivered to an end user.
Own compilation, using the following sources: Dow's Annual Report 2015 and Dow's Sustainability Report 2015.
http://storage.dow.com.edgesuite.net/dow.com/investors/2015_Dow_Chemical_Annual_Report.pdf
http://media-library.dow.com/WebContent/www-dow-com/Documents/Dow_2015_SustainabilityReport.pdf

Dow Chemical has published a Sustainability Report in accordance with GRI G4 and therefore follows the triple bottom line approach (economic, environmental and social). The company uses the term "sustainable chemistry" for its "cradle to cradle" concept (see 8.2.1.2). [186]

"DEDICATED TO SUSTAINABILITY

We have a legacy of innovation, leadership and action in sustainability. As we look ahead, we are committed to going beyond our current capabilities and the reach of our products and solutions. We pursue game-changing collaboration opportunities to set a higher bar for social and environmental progress. We aim to advance the well-being of humanity by helping lead the transition to a sustainable planet and society.

- **2025 SUSTAINABILITY GOALS**: We are embarking on the third stage of our sustainability journey with ambitious 2025 Sustainability Goals.
- OUR EXPERTISE: We practice the fundamentals of R&D – with deep expertise, capabilities and networks that are unparalleled in the industry.
- FOOTPRINT, HANDPRINT & BLUEPRINT: We are in the unique position of being able to help our customers and society become more sustainable.

ADDRESSING GLOBAL CHALLENGES

Driven by our rapidly expanding global population, we ensure our unique chemical, physical and biological science capabilities work together to provide innovative products and solutions, where they are needed most." [190]

8.2.1.2 Criteria

Dow's Sustainable Chemistry Index (SCI)

Dow developed the Sustainable Chemistry Index (SCI), a metric used to assess the relative sustainability performance of its product portfolio based on the sustainability attributes of its products. "SCI is comprised of a set of sustainability-related questions that span the full cradle-to-grave product life cycle; addresses environmental, social and economic benefits; and highlights sustainability opportunities and risks associated with Dow products." [184] The index combines several factors to determine whether products have sustainable chemistry advantages: [186]

[189] http://www.dow.com/en-us/news/press-releases/Dow%20Outstanding%20LGBT%20Ally%20Executives%20Future%20Leaders

[190] http://www.dow.com/en-us/science-and-sustainability

- Q1: Renewable/Recycled Content
- Q2: Resource Management
- Q3: Life Cycle Benefit
- Q4: Manufacturing Efficiency
- Q5: Social Need
- Q6: Manufacturing/Transportation
- Q7: Product Application
- Q8: Public Policy/End Of Life

Further details on the SCI methodology are not available. "In 2015, Dow delivered 25 percent ($12.4 billion) of sales from products that are "highly advantaged" by sustainable chemistry. These results surpassed the 10 percent target more than two-fold, and represent the realization of sustainable chemistry efforts under Dow's 2015 Sustainable Chemistry goal." Information on which of the products offered by Dow are "highly advantaged", is not available either.

Measuring sustainability progress 2015

Dow has selected ten criteria (metrics) for measuring its sustainability progress in relation to its seven sustainability targets for 2015 (Table 52).

Table 52: Dow Chemical: 2015 Sustainability Goals

Focus area	Metrics	Status 2015	Ambition 2015
Sustainable Chemistry	Increase the percentage of sales for products that are highly advantaged by sustainable chemistry to x%	25%	10%
Breakthroughs to World Challenges	Number of breakthroughs that will significantly help solve world challenges in the areas of food, water, health, energy and climate change	4 [1]	3 at least
Addressing climate change	Greenhouse gas emissions (metric tons)	-27% (-75 million t)	< 2006 levels
Energy efficiency and conservation	Reduction of energy intensity	-1.2%	-25% (baseline: 2006 levels)
Product safety leadership	Publication of product safety assessments (PSAs)	99% [2]	100%
Contributing to community success	Achieving individual community acceptance ratings at all Dow sites where the company has a major presence	10 [3]	19 [4]
Local protection of human health and the environment	% improvement of key indicators for EH&S operating excellence from 2005 baseline	See [5]	75% on average
	a) Injury and illness rate	0.16 [6]	0.12 [6]
	b) Spills	154 [7]	130 [7]
	c) Process safety incidents	~10 [8]	12 [8]

1 Omega-9 Oils, FILMTEC™ ECO Membrane Modules, BETAMATE™ Structural Adhesives and POLYOX™ Water-Soluble Polymers

2 "By the end of 2015, we published 510 (PSAs) covering 99% of Dow's annual revenue, with several PSAs in the final stages of review. Additionally, all of our 149 High-Priority Chemicals are now covered by a PSA."

3 "In the 10 locations that were surveyed, average Community Acceptance Ratings increased by 25%."

4 See Sustainable Report 2015, page 18

5 "Since 2005 we have achieved more than 1,500 fewer injuries and illnesses, more than 11,000 fewer spills, and 400 fewer process safety incidents."

6 See Sustainable Report 2015, page 47
7 See Sustainable Report 2015, page 62
8 See Sustainable Report 2015, page 49; status 2015 estimated using the graph
Own compilation, using the following source: Dow Chemical: Sustainability Report 2015.
http://media-library.dow.com/WebContent/www-dow-com/Documents/Dow_2015_SustainabilityReport.pdf

Only the first criterion can be regarded as specific to chemical industry and thus will not be found in other sectors. For instance, the criteria "breakthrough" or "product safety leadership" can be used by other sectors too (e.g. biotechnology, ICT).

Criteria for the "Breakthrough to World Challenges" goal

"A breakthrough is an innovation, whether in a technology or business model, that has the ability to scale to levels that will significantly impact the quality of lives around the world. … A "Breakthrough to World Challenges" can take many forms. Given this variety, Dow established basic screens to evaluate innovations for their impact toward alleviating world challenges. This screen is made up of five key areas, each of which is considered when evaluating the impact of an innovation:

- **Alignment** – The innovation aligns with one or more of the five key categories of world challenges: energy and climate change, water, food, housing and health.
- **Significance** – The innovation makes a positive impact today or in the near future. Breakthroughs are intended to be implementable rather than theoretical, providing significant, measurable impact. The measure of significance can vary depending on the type of innovation and the challenge addressed, but in all cases it must positively impact millions of human lives.
- **Benefits** – The benefits of implementing the innovation significantly outweigh any potential challenges.
- **Life Cycle View** – Each stage of the solution's "life cycle" – from development through manufacturing, distribution, use and end-life – is carefully vetted in regards to raw materials, energy use, water use, hazard profile, disposal and other social and environmental considerations.
- **Transparency** – The positives and negatives of the innovation are publicly disclosed and openly discussed with key stakeholders. Multiple aspects of the innovation are candidly and transparently evaluated." [191]

In 2015, Dow developed four "breakthroughs": [192, 193]

- **"Omega 9 Healthy Oils** have eliminated 1.5 billion pounds of bad fats from North American diets since 2005 without compromising oil performance or food taste.
- **FILMTEC™ ECO Reverse Osmosis Elements** deliver 40 percent better water purification using 30 percent less energy. In its first decade, the technology will produce 10 billion cubic meters of clean water – the volume of more than 4 million Olympic-sized swimming pools.
- **BETAMATE™ Structural Adhesives** deliver crash-durable bonding for lightweight vehicle construction, and improve fuel efficiency without sacrificing safety in new vehicles such as the Ford F-150. At the time this breakthrough was announced, industry adoption of BETAMATE™ Structural Adhesives has already saved approximately 2.65 billion gallons of gas – avoiding 23.3MM metric tons of CO_2 emissions.

191 Dow Chemical: Breakthrough to World Challenges Breakthrough Collaboration: Dow and Unilever. Lifebuoy™ Soap Featuring POLYOX™ Water-Soluble Polymers.
http://storage.dow.com.edgesuite.net/dow.com/sustainability/goals/Breakthrough-to-World-Challenges-Dow-Unilever-on-Lifebuoy-TM-Soap-feat-POLYOX-TM-Polymers-White%20Paper-141009.pdf

192 http://www.dow.com/en-us/science-and-sustainability/2025-sustainability-goals/delivering-breakthrough-innovations

193 This is a statement by Dow Chemical. The authors have no knowledge of scientific assessments / LCAs for the precise assessment of sustainability, since here only individual sustainability aspects are mentioned.

- **POLYOX™ Polymers for Lifebuoy soap** helps make soap more accessible for millions in the developing world. Washing hands with soap is a proven way to prevent the spread of life-threatening diseases, especially among children. In fact, nearly 2 million children under the age of 5 die each year from infectious diseases. Dow collaborated with Unilever to develop POLY-OX™ Polymers for a brand of Lifebuoy™ soap which costs 10 cents per bar and lasts an entire month."

Measuring sustainability progress 2025

"In 2015 Dow announced a strategic set of commitments designed to redefine the role of business in society. Dow's **2025 Sustainability Goals** use a global lens to magnify the Company's impact around the world, driving unprecedented collaborations to develop societal blueprints that will facilitate the transition to a sustainable planet and society. Through harnessing Dow's innovation strengths, global reach, and dedicated employee population, the Company has set bold and aggressive sustainability targets designed to develop breakthrough product innovations, positively impact the lives of 1 billion people, and deliver $1 billion in cost savings or new cash flow for the Company by valuing nature in business decisions." [184]

Table 53: Dow Chemical: 2025 Sustainability Goals [194, 195]

Focus area / Goal	Description	Key performance indicator	Ambition 2025
1 Leading the blueprint	Dow leads in developing a societal blueprint that integrates public policy solutions, science and technology and value chain innovation to facilitate the transition to a sustainable planet and society.	Sum of dialogues and collaborations	100 significant dialogues across the public and private sector 10 new collaborations
2 Delivering breakthrough innovations	Dow delivers breakthrough sustainable chemistry innovations that advance the well-being of humanity.	Ratio of benefit to global sustainable development vs. burdens	Dow will innovate to increase the positive net impact of products across all markets such that the benefit to global sustainable development exceeds burdens by six times.
3 Advancing a circular economy	Dow advances a circular economy by delivering solutions to close the resource loops in key markets.	Number of projects implemented	Dow will collaborate to implement six major projects that deliver solutions and advance the circular economy.
4 Valuing nature	Dow applies a business decision process that better accounts for the value of nature's services, which will deliver business value and natural capital value through projects that are good for the company and for ecosystems.	Net present value ($)	Dow will identify and implement business-driven project alternatives that will best enhance nature and deliver $1 billion in net present value.

[194] http://www.dow.com/en-us/science-and-sustainability/2025-sustainability-goals

[195] Dow Chemical: 2025 Sustainability Goals http://www.dow.com/-/media/dow/business-units/dow-us/science-and-sustainability/sustainability-reporting/2025-goals/2025-sustainability-goals-detailed-descriptions.ashx

Focus area / Goal	Description	Key performance indicator	Ambition 2025
5 Increasing confidence in chemical technology	Dow increases confidence in the safe use of chemical technology through transparency, dialogue, unprecedented collaboration, research and its own actions.	Measured level of support among key value chain and stakeholder representatives	Dow will achieve value chain and stakeholder support for the safe use of chemical technology to solve global challenges.
6 Engaging employees for impact	Dow people worldwide directly apply their passion and expertise to advance the well-being of people and the planet.	Sum of people whose sustainable development challenges have been positively impacted. [1]	Dow employees will give 600,000 hours to support students and teachers in science, technology, engineering and math (STEM) education. Dow volunteers will complete 700 sustainability projects around the world spending 400,000 hours. [184] Details[2]
7 World-leading operations performance	Dow maintains world-leading operations performance in natural resource efficiency, environment, health and safety.	Raw material efficiency utilization index; reduction rates (%) in freshwater intake intensity and waste intensity footprint; no exceeding of baseline emissions of air pollutants (2015) and GHG (2006); amount of power (MW) from renewable sources; number of unplanned safety events	Amongst others: +10% raw material efficiency utilization index relative to the 2015 baseline -20% freshwater intake intensity at key water stressed sites -20% waste intensity footprint Offset emissions of priority compounds, VOCs, and NOx despite growing. Dow's absolute greenhouse gas emissions will not exceed the 2006 baseline. Obtaining 400 MW of Dow's power demand from renewable sources. By 2020, Dow will ensure that its trajectory for absolute emissions from operations and purchased power meet internationally recognized targets for a 2°C maximum global temperature rise.

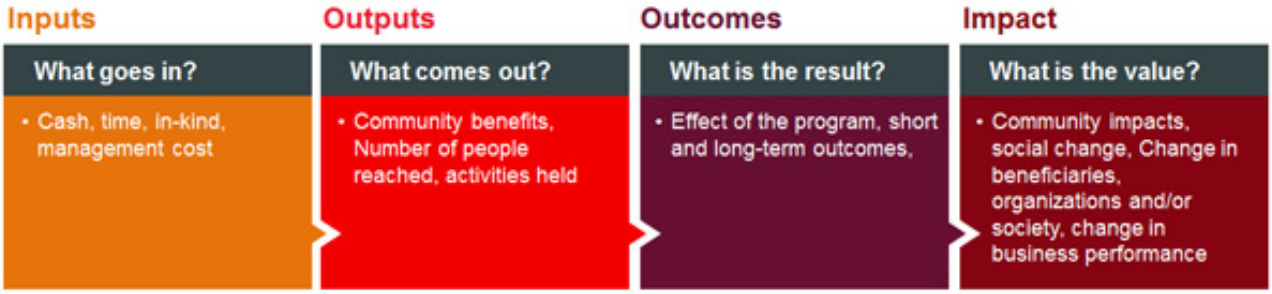
1 see below: Measuring Dow's progress

2 "Deliverance of 700 projects and achieving 8 percent work force participation and 400,000 hours of engagement through Dow Corps projects related to community well-being; increasing food productivity and preventing waste; water access and reuse; and energy efficiency and affordable housing. Positively impacting students and teachers through STEM Ambassadors, a program where employees take their real-world career experiences and knowledge into the classroom, exposing students and teachers to STEM through career discussions, hands-on activities and project-based learning. Through this effort, STEM Ambassadors will engage 10 percent of the work force through 600,000 hours of engagement."

Own compilation, using the following sources: http://www.dow.com/en-us/science-and-sustainability/2025-sustainability-goals and http://www.dow.com/-/media/dow/business-units/dow-us/science-and-sustainability/sustainability-reporting/2025-goals/2025-sustainability-goals-detailed-descriptions.ashx

Measuring Dow's progress

One of Dow's key performance indicator is the „sum of people whose sustainable development challenges have been positively impacted. A critical component of this 2025 Sustainability Goal is tracking **impact**. … The methodology for doing this effectively is the work of a dedicated I/T team, which is expected to have a tool in place by mid-2016. While we await the final tracking tool, the employees should implement interim tracking measures.



- **Inputs**: What goes in? Cash, time, in-kind, management cost
- **Outputs**: What comes out? Community benefits, number of people reached, activities held
- **Outcomes**: What is the result? Effect of the program, short and long-term outcomes
- **Impact**: What is the value? Community impacts, social change; change in beneficiaries, organizations and/or society; change in business performance"[196]

8.2.1.3 Organizational structure and implementation

Sustainability is integrated in management processes:[184]

- **"Dow's Board of Directors** is closely involved in the strategy and operations of the company – conducting thorough reviews and asking difficult questions."
- There are four **Board Committees**: Audit Committee, Governance Committee, Compensation and Leadership Development Committee, Environment, Health, Safety and Technology Committee.
- "The **Environment, Health, Safety and Technology Committee** of the Board of Directors (the **"Committee"**) assists the Board of Directors in fulfilling its oversight responsibilities by assessing the effectiveness of programmes and initiatives that support the Environment, Health and Safety (EH&S) and sustainability, innovation, and technology policies and programmes of the Company and by advising the Board on matters impacting corporate social responsibility and Dow's public reputation."
- "The **Executive Sustainability Team** is accountable to the CEO and serves as Dow's management governance body for the company for Sustainability, Environment, Health & Safety Policy:
  - Assures adherence to the corporate EH&S Policy and revise and approve when deemed necessary.
  - Decision-making for EH&S issues and strategic direction that need corporate management level approval (e.g. corporate elevated product and process risk management reviews, compliance plan performance).
  - Ensures continued progress is made toward achieving Dow's Sustainability goals.
  - Provides strategic direction and oversight to Dow's Corporate Reputation to ensure the respect of our stakeholders.

[196] http://www.dow.com/en-us/science-and-sustainability/2025-sustainability-goals/engaging-employees-for-impact

- Provides oversight on behalf of the Executive Committee for the following corporate management committees: Corporate Reputation Team, Crisis Management Team, Public Issue Strategy Board, Remediation Strategy Board, and Corporate Contribution Committee."
- "2015 members of the Executive Sustainability Team were:
  - Neil Hawkins (Chair): Corporate Vice President, Chief Sustainability Officer, Environment, Health & Safety
  - Jim Fitterling: **Vice Chairman**, Business Operations
  - Joe Harlan: Chief Commercial Officer and Vice Chairman, Market Business
  - Peter Holicki: Corporate Vice President of Manufacturing and Engineering and Environment, Health & Safety Operations
  - Duncan Stuart: Associate General Counsel, Corporate Transactions
  - Diego Donoso: Business President, Packaging and Specialty Plastics
  - Pat Gottschalk: Business President, Dow Coating Materials & Performance Monomers"
- "The **management structure and responsibilities** are: Neil Hawkins, Corporate Vice President, Chief Sustainability Officer, Environment, Health & Safety reports to Jim Fitterling, Vice Chairman, Business Operations who reports to Andrew Liveris, Chairman of the Board of Directors, President and Chief Executive Officer."

- "Each business has a **Global Product Sustainability Leader**, who, together with a global team, is responsible for implementation of the business global product stewardship program. These leaders report to the Director of Global Product Sustainability and Compliance."

Sustainability performance is supported for example by **incentives**: "Performance criteria for executive compensation is primary factor of net income, management operating cash flow, and an individual performance multiplier ranging from 0-125 percent of the target award. Environment, Health, and Safety are thoroughly embedded in the leadership expectations of Dow executives, and executives are held accountable for environment, health, and safety objectives through the individual performance process, which therefore significantly impacts the annual cash incentive. …

During the GPP (Global Pay Planning) cycle, annual base pay increase guidelines and Performance Award payout guidelines are created for each employee by Dow's global compensation department. Supervisors make compensation decisions for their employees using these guidelines and assessing the employee's overall contribution and goal completion, **including performance on sustainability goals**. All compensation decisions are reviewed by second-level leaders and ultimately functional leadership for equity and consistency." [184]

8.2.1.4 Evaluation

Dow gives an outstanding definition (understanding) of sustainable chemistry: "Green chemistry is a set of principles to design, but **sustainable chemistry** looks beyond only a science. It is a catalyst for change, an innovative approach to problem-solving and a long-term solution to global sustainability challenges. … Ultimately, chemistry and collaboration – and people – have the power to bend that straight line to a more positive point in the future, where nature and therefore human prosperity are in balance" This agrees almost entirely with the definition used in this study.

With the aim of a transition to a sustainable planet and society, Dow Chemical consistently introduces impact-oriented goals, key performance and in addition societal impact indicators with its sustainability programme 2025. Here, apart from (classic) performance indicators, societal impact indicators are introduced: measured level of support among key value chain and stakeholder representatives, and sum of people whose sustainable development challenges have been positively impacted. These criteria are not specific to chemical industry and can thus be used as a blueprint for other sectors: "Dow's 2025 Sustainability Goals use a global lens to magnify the Company's impact around the world, driving

unprecedented collaborations to develop societal blueprints that will facilitate the transition to a sustainable planet and society."

Table 54 provides an overview of the main criteria for the evaluation of the company's sustainability approach.

Table 54: Dow Chemical: Evaluation of sustainability approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	Definition (understanding) of sustainable chemistry agrees almost entirely with the definition used in this study: "Green chemistry is a set of principles to design, but sustainable chemistry looks beyond only a science. It is a catalyst for change, an innovative approach to problem-solving and a long-term solution to global sustainability challenges. … Ultimately, chemistry and collaboration – and people – have the power to bend that straight line to a more positive point in the future, where nature and therefore human prosperity are in balance."[185]
Consistency of indicator concept and how it is monitored	Indicator concept is consistent with the company's approach. Monitoring is done through annual publication of Sustainability Report.
Role of SDGs in the concept	All SDGs are addressed. "Dow's 2025 Sustainability Goals drew from the UN Goals as they were developed concurrently and like the UN's goals, ours are not merely business as usual." [184]
Probability of implementation	Ambitious, but feasible.
Overall impression	Best practice, role model.

Source: Own compilation

The indicator concept is consistent with the company's approach. Monitoring is done through Annual publication of Sustainability Report.

"Our ambitious 2025 Sustainability Goals address each of the UN SDGs and will incorporate the value of nature and society into all of our business decisions. Dow's 2025 Sustainability Goals drew from the UN Goals as they were developed concurrently and like the UN's goals, ours are not merely business as usual. They will lead us to transform our company. By working together, at the intersections of business, government, and civil society, we can leverage the best of what each of us has to offer – and help create a better world." [184]

8.2.2 DuPont

On 11 December 2015, DuPont and The Dow Chemical Company announced "that their boards of directors unanimously approved a definitive agreement under which the companies will combine in an all-stock merger of equals. The combined company will be named DowDuPont. The parties intend to subsequently pursue a separation of DowDuPont into three independent, publicly traded companies through tax-free spin-offs. This would occur as soon as feasible, which is expected to be 18-24 months following the closing of the merger, subject to regulatory and board approval." [182] DuPont was therefore selected for analysis in order to compare it with its future partner, Dow Chemical.

8.2.2.1 Sustainability approach

DuPont is currently not ranked in the chemicals sector as rated by RobecoSAM (see Table 76), but has been named to the North America Dow Jones Sustainability Index (2014)[197] and to the NASDAQ OMX CRD Global Sustainability Index (year unknown)[198]. Table 55 provides an overview of the company and its sustainability approach, mainly based on 2015 DuPont Data Book[199], Sustainability Report 2015[200] and GRI Report 2016[201].

Table 55: DuPont: Short Characterization

Subject	Information
Name/title	DuPont
URL(s)	http://www.dupont.com/
Country (head office)	Wilmington, Delaware, USA
Branches	Operations in 90 countries and hundreds of locations around the world
Products, market	► Agriculture & nutrition: Seeds, agricultural chemicals, specialty food ingredients ► Bio-based industrials: Enzymes, biofuels, biomaterials ► Advanced materials: Advanced polymers, protective materials, electronic materials, alternative energy Main market sales are in the USA and Canada; 60% of consolidated net sales are to customers outside the USA.
Economic KPIs	$25.13 billion net sales $5.095 billion adjusted EBITDA
Employees	Approximately 52,000
Ratings	North America Dow Jones Sustainability Index (2014) [197]
Mission	"DuPont's mission is Sustainable Growth which we define as creating shareholder and societal value while reducing the environmental footprint in the value chains in which we operate." [202]
Principles/values	Safety and health, environmental stewardship, respect for people, highest ethical behaviour [203]
Strategy	"Sustainable Growth efforts are essential to DuPont's overall strategy. We believe that only those companies and industries that provide value to society in a way that is protective of the world's resources will be competitive in the 21st Century. … DuPont is actively pursuing sustainable growth by: ► Continuing to set footprint reductions goals to reduce our impact in

[197] 2014 SUSTAINABILITY PROGRESS REPORT. http://www.dupont.com/content/dam/assets/corporate-functions/our-approach/sustainability/documents/2014-dupont-sustainability-progress-report.pdf

[198] http://www.dupont.com/corporate-functions/sustainability/performance-reporting/awards-recognition.html

[199] 2015 DuPont Data Book. http://s2.q4cdn.com/752917794/files/doc_downloads/2015/DuPont_2015_DataBook-FINAL.pdf

[200] DUPONT 2015: SUSTAINABILITY PROGRESS REPORT. http://www.dupont.com/content/dam/dupont/corporate/our-approach/sustainability/documents/DuPont-Sustainability-Report-2015_111615.pdf

[201] DUPONT 2016 GLOBAL REPORTING INITIATIVE REPORT http://www.dupont.com/content/dam/dupont/corporate/our-approach/sustainability/documents/2016-sustainability-documents/DuPont%202016%20GRI%20Report.pdf

[202] http://www.dupont.com/corporate-functions/our-company/insights/articles/position-statements/articles/sustainable-development-local-sustainability.html

[203] http://www.dupont.com/corporate-functions/our-company/core-values.html

Subject	Information
	areas like energy, greenhouse gas emissions, water use, and air carcinogens. ► Setting market facing goals to drive the way that we are investing our R&D and growing our revenues. ► Seeking to be a welcome neighbor of communities in which we operate as well as a welcome member of society. This requires meeting the public's expectations of economic competitiveness and social responsibility, including environmental protection." [202]
CSR report	GRI report, GRI G4, in accordance, core
Definition of sustainable chemistry OR sustainability	"Sustainable development involves the ability of a community, country, region or world to maintain or improve the present generation's quality of life, while protecting the ability of future generations to enhance their quality of life. Sustainable development integrates social, economic and environmental needs to develop better solutions to today's problems while also providing good stewardship of the resources needed for the future. Recognizing that the Earth's resources are limited and that conservation and innovation are both necessary, many people and organizations with diverse views are coming together to work on issues of common interest." [202]
Concept of selected indicators	GRI-oriented in reporting, including LCA approach for GHG. Sustainability goals: ► Sustainable Innovation Goal: Too vague, hardly any information on methodology, no information on references. ► 2020 Food Security Goals: One of the quantified goals is questionable, since important sustainability effects are not considered (GM seeds + agrochemicals). ► 2020 Footprint Goals: Only two (classic) ecological performance indicators (GHG emissions, non-renewable energy use) quantified, two further indicators too vague.
Launch year, change in concept (if any) since then	2015: New sustainability goals 2020
Instruments and measures for implementation	Incentives: "Each year, DuPont sets corporate objectives for the company that include both financial and non-financial targets. Nonfinancial targets include advancing our Core Values of Safety and Health, Environmental Stewardship, Highest Ethical Behavior, and Respect for People."[201] No information on remuneration practice below the CEO/non employee directors level.
Status of implementation (e.g. description of best practice etc.)	Programme was designed in 2015, no data for 2016 available yet
Status and type of monitoring including e.g. time series of indicator measurements	"Each year, we submit our climate and water performance to the CDP (formerly Carbon Disclosure Project), publish a Global Reporting Initiative report, which provides stakeholders with detailed information about all aspects of our environmental and social performance, and

Subject	Information
	make available other documents and certificates that our stakeholders may find useful." [204]
Stakeholder engagement	**GRI G4-24-26 Stakeholder engagement**: Short description of key stakeholders (employees, customers, investors, suppliers, trade associations, government agencies, global civil society, academic, and communities) and method of engagement. DuPont is member/partner of (amongst others): ► World Business Council for Sustainable Development ► World Economic Forum ► World Environment Center ► World Resources Institute ► Together for Sustainability
Additional information	Several awards for working place quality or diversity in 2016:[205] ► Working Mother 100 Best Companies: DuPont Named to Working Mother 100 Best Companies for the 26th Time ► Disability Equality Index Best Places to Work: DuPont Receives 100 on the 2016 Disability Equality Index ► America's Best Employers: Forbes Magazine ► Top 25 Noteworthy Companies: DuPont Earns Place in 25 Noteworthy Companies for Diversity by Diversity Inc. ► Best Places to Work for Lesbian, Gay, Bisexual and Transgender (LGBT) Equality (2016): Human Rights Campaign (HRC)

Own compilation, using the following sources: 2015 DuPont Data Book, DuPont Sustainability Report 2015 and DuPont GRI Report 2016.
http://s2.q4cdn.com/752917794/files/doc_downloads/2015/DuPont_2015_DataBook-FINAL.pdf
http://www.dupont.com/content/dam/dupont/corporate/our-approach/sustainability/documents/DuPont-Sustainability-Report-2015_111615.pdf
http://www.dupont.com/content/dam/dupont/corporate/our-approach/sustainability/documents/2016-sustainability-documents/DuPont%202016%20GRI%20Report.pdf

8.2.2.2 Criteria

DuPont follows the triple bottom line approach (sustainable development integrates social, economic and environmental needs …).

"Since 1990, DuPont has been at the forefront of the sustainability movement. Twenty-five years later, we continue our leadership journey by announcing a set of 2020 Sustainability Goals that integrate sustainability in our innovation process, further improve our operational footprint, and continue our efforts to enhance global food security. As we look toward the future, science and innovation will be essential to making our planet's resources secure." [206]

DuPont Sustainable Innovation Goal

"Our Sustainable Innovation Goal is the centerpiece for sustainability at the Next Generation DuPont—and of our 2020 Sustainability Goals. It commits us to further embedding sustainability in our innovation process so that products in our pipeline will contribute to a safer, healthier, more sustainable world. Because we are committed to helping end hunger and building global food security, Food Security is also at the

[204] http://www.dupont.com/corporate-functions/sustainability/performance-reporting/sustainability-reports.html
[205] http://www.dupont.com/corporate-functions/our-company/awards-and-recognitions.html
[206] http://www.dupont.com/corporate-functions/sustainability/sustainability-commitments/goals-progress.html

heart of our priorities. Lastly, with a continuing focus on improving our footprint, we have set new goals in emissions, water use and waste…. We are creating sustainable, renewable, innovative, market-driven solutions for some of the world's greatest challenges." [207] The goal is to create a **Pipeline of Sustainable Innovations**. The criteria and metrics are shown in Table 56.

Table 56: DuPont: Criteria and the metrics for Sustainable Innovations

Goal	Criteria
Safer	► Improved food safety and quality ► Help protect people/users ► Reduced toxicological risk
Healthier	► Improved nutrition (human and animals) ► Disease prevention and control (human and animals)
More sustainable	► Reduced energy and water use ► Reduced GHG, pollution and waste ► More efficient resource and material use ► Improved end of life/disposal ► Benefits ecosystems and biodiversity ► Use of non-depletable resources ► Supply chain sustainability (social and environmental) ► Enhanced accessibility (affordability, availability and quality) of new technologies with sustainability benefits to underserved populations
Metric group	**Metrics**
Process metric	► Number of major growth innovations with quantifiable benefits (safer, healthier, more sustainable) ► Report on an annual basis ► Required for all major growth innovations
Impact metric	► Sum up collective, realized benefits contributing to safer, healthier, more sustainable world ► Report on an annual basis ► Required for all major growth innovations. Other new products can opt-in and measure benefits using defined criteria and process.

Own compilation, using the following source: http://www.dupont.com/corporate-functions/sustainability/sustainability-commitments/goals-progress/sustainable-innovation-goal.html

There is no information about how the criteria are applied or counterweighed, in case of countervailing effects (e.g. reduced GHG, but negative effect on biodiversity). The methodology has a major influence on the results, especially for the criteria of supply chain sustainability (social and environmental) and enhanced accessibility (affordability, availability and quality) of new technologies with sustainability benefits to underserved populations.

Only the methodology for the calculation of the reduction of energy requirements for products and services (G4-EN7) is described: "To calculate the savings above, IPCC 4th edition 100 year GHG data were used to identify relevant global warming potential figures for product LCAs. The specific methodology and assumptions made when calculating the emissions avoided vary from product to product, and are often connected to a more detailed product-level LCA. An internal team comprised of members of our sustainability and engineering organizations (with expertise in life cycle analysis) identifies those products with use-phase GHG benefits, and calculates the emissions avoided." [201] It is not how-

[207] http://www.dupont.com/corporate-functions/sustainability/sustainability-commitments/goals-progress/sustainable-innovation-goal.html

ever clear what the reference for GHG reduction or the other criteria is (see e.g. DSM, page 131: Products and services that, when considered over their whole life cycle, offer a clear environmental benefit (ECO+) and/or a social benefit (People+) *compared to competing mainstream products that fulfil the same function or mainstream reference services*).

DuPont 2020 Food Security Goals

DuPont will develop innovations "that will produce more food, enhance nutritional value, improve agriculture sustainability, boost food safety, extend food freshness and reduce waste." The criteria and metrics for the 2020 Food Security Goals are shown in Table 57.

Table 57: DuPont: Goals and metrics for the Food Security Goals 2020

Food Security Goal	Goal/metric
Innovate to feed the world	► **$10 billion** in research & development investment (2012-2015: $4.877 B; remaining: $5.123 B) ► and **4,000 new products** introduced (2012-2015: 2.968; remaining: 1.032)
Improve rural livelihoods	► Improve the livelihoods of **3 million farmers** and their rural communities (2012-2015: 1,223,466; remaining: 1,776,534)
Engage and educate our youth	► Facilitate **2 million engagements with youth** around the world in educational opportunities (2012-2015: 2,212,104; **exceeded** by 212,104)

Source: Own compilation

One of DuPont's endeavours to reach the goal *Improve rural livelihoods* is its Advanced Maize Seed Adoption Program (AMSAP). AMSAP is a Public-Private Partnership between DuPont, USAID[208] and the government of the partner country (e.g. Ethiopia, Ghana, Zambia [200]). The underlying business model is the development of new markets for e.g. genetically modified seeds, fertilizers and pesticides. "Previously, most farmers bought their seeds and inputs from cooperatives, which usually did not offer any choice of seeds. Now, through the centers, farmers have options for quality tools and inputs as well as getting agronomic and veterinary advice. The DuPont seeds sold in Ethiopia are genetically modified to produce greater yields in the country's climate. … In addition to providing improved maize seeds, the AMSAP partners use demonstration plots to show lead farmers in Ethiopia the hardiness of the new hybrid seeds, as well as best practices for planting, weeding, fertilizing and harvesting to generate the highest yields. These lead farmers serve as guides to other farmers in the surrounding communities who want to purchase new seeds." [209] The sustainability assessment of programmes like these has to take further social (making dependent on the supplier) and ecological aspects into account. In addition to the controversial use of GM seeds, this is the additional use of pesticides[210], soil health and climate change. In his report to the UN General Assembly in August 2015, the Secretary-General stated[211]: "63. It is of critical importance to introduce agricultural practices that move beyond yield gains to build up organic matter in the soil. This will contribute significantly to mitigating climate change while also reducing soil erosion and increasing soil fertility and soil health."

[208] https://www.usaid.gov/news-information/videos/advanced-maize-seed-adoption-program

[209] https://www.feedthefuture.gov/article/public-private-partnership-delivers-seeds-change-ethiopia

[210] http://www.dupont.co.za/products-and-services/crop-protection/maize-farming/products/acanto-plus-280sc-maize-fungicide.html

[211] United Nations, General Assembly: Seventieth session: Agricultural technology for development. Report of the Secretary-General. A/70/298, 6.8.2015. https://sustainabledevelopment.un.org/index.php?page=view&type=111&nr=8396&menu=35

Programmes for achieving the goal *Engage and educate our youth* "ranged from collaboration with 4-H in Africa to educate and encourage future farmers to promoting safe farming practices to interactive programs and computer donations for Brazilian third and fourth graders". [200]

DuPont 2020 Footprint Goals

"We have been focusing on improving our footprint for over twenty-five years. Now, we take the next step on our journey." The criteria and metrics for the 2020 Footprint Goals are shown in Table 58.

Table 58: DuPont: Goals and metrics for the Footprint Goals 2020

Footprint Goal	Goal/metric
Smarter energy use	► 10% reduction in non-renewable energy use per price-adjusted Dollar revenue (baseline: 2010; 2015: 3.7% reduction)
Greenhouse gas emissions reduction	► 7% reduction in greenhouse gas emissions intensity (baseline: 2015)
Waste reduction	► Each DuPont business will meet a 2020 waste goal appropriate to its operations.
Water stewardship	► All DuPont sites in locations evaluated as high or extremely high water-risk will establish water risk mitigation plans and complete priority implementation objectives by 2020.

Own compilation, using the following sources: DuPont Sustainability Report 2015
http://www.dupont.com/content/dam/dupont/corporate/our-approach/sustainability/documents/DuPont-Sustainability-Report-2015_111615.pdf

The seriousness of some goals is questionable. For example, the water stewardship goal primarily aims to reduce the company's economic risk, the ecological benefit seems to come second. The waste reduction goal (*Each DuPont business will meet a 2020 waste goal appropriate to its operations*.) is trivial.

8.2.2.3 Organizational structure and implementation

Sustainability is integrated in management processes:

- The **DuPont Board of Directors** consists of the Chair of the Board and Chief Executive Officer, Edward D. Breen, and a further eleven directors, including two women. The Board "is responsible for broad corporate policy and overall performance. Board members oversee the management and stewardship of the company in order to enhance DuPont's long-term value and vitality."[212] "It delegates authority for management of the company, including economic, environmental, and social issues, to senior function and business leaders."[201]
- The senior function and business leaders "further delegate authority to the relevant function or team within the company. For example, responsibility for DuPont corporate sustainability strategy, including goal-setting and reporting, has been delegated to the **DuPont Vice President of Public Policy and Chief Sustainability Officer**, who manages the corporate sustainability team." [201]
- "The Board maintains five **committees**: Environmental Policy and Safety, Audit, Human Resources and Compensation, Corporate Governance, Science and Technology.
- The two Board Committees with primary responsibility for sustainability-related topics are:

[212] http://www.dupont.com/corporate-functions/our-company/leadership/board-of-directors.html

- The **Environmental Policy & Safety Committee**, which assists the Board of Directors in fulfilling its oversight responsibilities by assessing the effectiveness of programmes and initiatives that support the company's Safety, Health and Environment (SHE), Product Stewardship (PS&R), and Sustainability programmes.
- The **Human Resources and Compensation Committee**, which discharges the responsibilities of DuPont's Board of Directors relating to the compensation and benefits of DuPont's executive officers and oversees the effective recruitment, development and retention of diverse talent necessary to support the long-term success of DuPont." [201]

Sustainability performance is supported for example by **incentives**: "Each year, DuPont sets corporate objectives for the company that include both financial and non-financial targets. Nonfinancial targets include advancing our Core Values of Safety and Health, Environmental Stewardship, Highest Ethical Behavior, and Respect for People. These corporate objectives serve as the guiding goals for the organization and are incorporated into the performance metrics of employees, including executive leadership, as appropriate based on level and area of responsibility. For example, our **Chief Sustainability Officer**, who is a member of the DuPont executive leadership team, is responsible for driving progress against our corporate sustainability goals." [201] For example, the CEO's salary consists of 11% fixed and 89% performance-based salary; for NEOs (Named Executive Officers) the ratio is 22%/78%. [213]

8.2.2.4 Evaluation

DuPont provides no definition of sustainable chemistry. The company's understanding of sustainable development follows the triple bottom line approach: "Sustainable development integrates social, economic and environmental needs to develop better solutions to today's problems while also providing good stewardship of the resources needed for the future."

DuPonts's sustainability goals (and indicators) are not completely consistent with its understanding of sustainability. The Sustainable Innovation Goal is too vague, there is almost no information on methodology or on references. Regarding the 2020 Food Security Goals, one of the quantified goals has to be regarded as questionable, since other important sustainability effects are not considered (GM seeds + agrochemicals). For the 2020 Footprint Goals, there are only two (classic) ecological performance indicators (GHG emissions, non-renewable energy use) quantified, two further indicators are too vague.

Monitoring is done through annual publication of Sustainability Report.

For DuPont, the SDGs are not drivers: "In 2015, the United Nations released a set of Sustainable Development Goals (SDGs). While these goals are primarily aimed at governments around the world, DuPont — along with other companies — is engaged in the discussion on how to achieve these goals. … DuPont supports the SDGs and stands ready to collaborate with its stakeholders to help achieve them. The chart … shows how the DuPont 2020 Sustainability Goals – launched in November 2015 and comprised of Innovation, Food Security, and Footprint – align with and support attainment of the UN SDGs." [201] This is too general and of little meaning.

[213] DuPont: A Market-Driven Science Company. Leveraging Good Governance and Strategic Vision to Build a Sustainable Future. November 2014 http://s2.q4cdn.com/752917794/files/DuPont-Governance-Presentation-November-2014-FINAL_v001_z224f9.pdf

Figure 6: DuPont: DuPont supports UN Sustainable Development Goals

Source: DuPont GRI Report 2016. http://www.dupont.com/content/dam/dupont/corporate/our-approach/sustainability/documents/2016-sustainability-documents/DuPont%202016%20GRI%20Report.pdf

Table 59 provides an overview of the main criteria for the evaluation of the company's sustainability approach.

Table 59: DuPont: Evaluation of sustainability approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No definition of sustainable chemistry; understanding of sustainable development follows the triple bottom line approach.
Consistency of indicator concept and how it is monitored	Monitoring is done through annual publication of Sustainability Report.
Role of SDGs in the concept	For DuPont, the SDGs are not drivers: "In 2015, the United Nations released a set of Sustainable Development Goals (SDGs). While these goals are primarily aimed at governments around the world, DuPont — along with other companies — is engaged in the discussion on how to achieve these goals."
Probability of implementation	Sustainability goals and indicators unambitious and therefore feasible.
Overall impression	Compared to other chemical companies (AkzoNobel, DSM, Dow Chemical), DuPont's Sustainability Programme 2020 is less ambitious and convincing and has at least one questionable goal.

Source: Own compilation

8.3 Asia

8.3.1 PTT Global Chemical PCL, Thailand

8.3.1.1 Sustainability approach

PTT Global Chemical PCL is best Asian chemical company (5th place in the Silver Class) in the chemicals sector as rated by RobecoSAM (see Table 76). Table 60 provides an overview of the company and its sustainability approach, mainly based on its Annual Report 2015[214], its Sustainability Report 2015[215], its Integrated Sustainability Report 2015[216] and its English website.

Table 60: PTT Global Chemical PCL: Short Characterization

Subject	Information
Name/title	PTT Global Chemical PCL
URL(s)	http://www.pttgcgroup.com/en/home
Country (head office)	Bangkok, Thailand
Branches	Unknown number of sites in six countries (Thailand, France, Indonesia, Malaysia, USA, Germany)
Products, market	PTTGC is Thailand's largest petrochemical and refining company. Its products are high-quality petroleum products (light, middle and heavy distillates), aromatics, olefins, polymers (HDPE, LLDPE, LDPE, PS), ethylene oxide-based products, "green chemicals" (fatty alcohols, glycerine, methyl ester, fatty alcohol ethoxylate), high volume specialties (toluene diisocyanate, hexamethylene diisocyanate and its derivatives) and phenol.
Economic KPIs	THB 400,128 million revenue THB 52,359 million EBITDA
Employees	5,738
Ratings	Dow Jones Sustainability World Index (DJSI World) 2016 Silver Class (5th place) in the chemicals sector
Mission	**"Shareholder**: We deliver the best business performance through trustworthiness to create fair and sustainable value for shareholders. **Society**: We engage and integrate social and environment to our business with responsibility and care for sustainable development. **Business Partner**: We provide superior solutions from innovative products and services to be the best choice for business partners. **Employee**: We create a learning organization and a happy workplace to cultivate proficient workforces with profound engagement and commitment to professional excellence."[217]
Principles/values	GC SPIRIT: Global mindset, customer focus, synergy, performance excellence, innovation, responsibility for society, integrity & ethics, trust & respect[218]

[214] PTT Global Chemical PCL: Annual Report 2015 http://pttgc.listedcompany.com/misc/AR/20160314-pttgc-ar2015-en-02.pdf

[215] PTT Global Chemical PCL: Sustainability Report 2015 http://www.pttgcgroup.com/src/download/sustain/20160307-pttgc-sd-2015.pdf

[216] PTT Global Chemical PCL: Integrated Sustainability Report 2015 http://www.pttgcgroup.com/src/download/sustain/20161006-pttgc-isr-2015.pdf

[217] http://www.pttgcgroup.com/en/aboutus/vision

[218] PTT Global Chemical PCL: Business Code of Conduct: Vision Mission Values http://www.pttgcgroup.com/src/misc/cg/code-conduct/2016/20160519-pttgc-vision-mission-value-th.pdf

Subject	Information
Strategy	"PTTGC's corporate direction and strategies have focused on sustaining its competitiveness at top level amongst its peers. … Our strategies consist of 3 strategic pillars and 1 strategic enabler as below: 1) Sustain Core … 2) Accelerate Growth Levers … 3) Balance Business & Social Value … 4) Strengthen Enablers …" (Annual Report 2015[214], page 7)
CSR-Report	2015, GRI G4, in accordance, option "core", + GRI G4's Oil and Gas Sector Supplement, in addition: Integrated
Definition of sustainable chemistry OR sustainability	"At PTT Global Chemical Public Company Limited, three pillars must be taken into consideration for conducting sustainable business – economy, social and the environment – in all that we do."[216]
Concept of selected indicators	2015: GRI-oriented, including LCA approach (carbon footprint, global warming footprint) 2025 goals: Besides (classic) performance indicators, societal impact indicators are introduced: ► Position in Dow Jones Sustainability Indices (DJSI) ► Customer and supplier satisfaction.
Launch year, change in concept (if any) since then	n.a.
Instruments and measures for implementation	"PTTGC has expanded sustainability aspects as a part of team KPIs in core business practices to ensure that BUs delivers tangible ESG results i.e. green procurement, operational efficiency, and effective CSR programs. By this strategy, cumulative team efforts should result in the recognition of PTTGC's sustainability performance by international rating agencies – a Corporate KPI." [216]
Status of implementation (e.g. description of best practice etc.)	In practice. Best practice projects, such as the High Selectivity Catalyst (HSC) project
Status and type of monitoring including e.g. time series of indicator measurements	**Reporting**: Annual publication of sustainability report, GRIlevel
Stakeholder engagement	**GRI G4-24, 25, 27 Stakeholder engagement**: Very detailed description of process approach for different stakeholders (1) Shareholders 2) Customers 3) Partners 4) Creditors 5) Government 6) Employees 7) Communities, Society and Environment and 8) NGOs). [216] PTTGC is member/partner of (amongst others): ► Carbon Disclosure Project ► United Nations Global Compact (UNGC) ► Collective Action Coalition (CAC) against Corruption, a national anti-corruption organization ► Tomorrow (or Together?) for Sustainability (TfS)

Subject	Information
Additional information	International awards and recognitions 2016 (selection):[219] ► PTTGC was recognized by the CDP as a Climate Disclosure Leader for the third consecutive year, achieving full score (100). CDP is a widely accepted organization that assesses environmental management of companies worldwide. ► PTTGC is the first company in Thailand that made a commitment to the UN Global Compact at the highest level: LEAD. ► 6th Asian Excellence Award 2016: PTTGC won four Corporate Governance Asia Awards 2016: Asia Best CEO, Asia Best CSR, Best Environment Responsibility and Best Investor Relation Company. The prizes were awarded by Corporate Governance Asia.

Own compilation, using the following sources: PTTGC's Annual Report 2015, PTTGC's Sustainability Report 2015, PTTGC's Integrated Sustainability Report 2015 and PTTGC's English website
Annual Report 2015: http://pttgc.listedcompany.com/misc/AR/20160314-pttgc-ar2015-en-02.pdf Sustainability Report 2015 http://www.pttgcgroup.com/src/download/sustain/20160307-pttgc-sd-2015.pdf
Integrated Sustainability Report 2015 http://www.pttgcgroup.com/src/download/sustain/20161006-pttgc-isr-2015.pdf

8.3.1.2 Criteria

Measuring sustainability progress in Product Stewardship

PTTGC has selected six criteria (metrics) for measuring its sustainability progress in relation to its sustainability targets for Role Model in Product Stewardship. Table 61 shows the corresponding sustainability targets. In addition, "PTTGC focuses on the development of sustainable products, particularly green products and aims to conduct Life Cycle Assessment for all product grades by 2016 and to have all product grades certified with Carbon Footprint Reduction labels or Global Warming Reduction labels by 2020. Furthermore, PTTGC has projected to communicate on Product Safety and Toxicity disclosure in 2017. … In 2015, all of PTTGC group's product grades were certified by the Thailand Greenhouse Gas Management Organization (Public Organization) (TGO) and received the Carbon Footprint of Products (CFP) label, while 44 product grades of our Polyethylene (PE), Aromatics, Petroleum, Green Chemicals and Ethoxylate products received TGO certified and labels for Carbon Footprint Reduction (CFR)."

Table 61: PTTGC: Sustainability Targets: Role Model in Product Stewardship

Focus area	Metrics	Target 2015	Status 2015	Target 2016 (2020)
Sustainability foundation				
1. Dow Jones Sustainability Indices (DJSI)	Position in the Top 10 percent of DJSI World	Retain position	Ranked 6th in the DJSI World Members in the chemicals sector	Continuously retain position
Innovation for future				
2. EBITDA for Green Chemicals	Million Baht	894	833 (does not include impairment)	1,041

[219] http://www.pttgcgroup.com/en/sustainability/awards-recognition

Focus area	Metrics	Target 2015	Status 2015	Target 2016 (2020)
3. EBITDA for high-volume specialties	Million Baht	1,805	1,846	2,054
4. R&D budget is 3% of gross profit	Million Baht	CAPEX: 237 OPEX: 287 Total: 524	196 191 387	510 289 799
5. Patents (applications)	Number	6	9	10
6. Communication – satisfaction – evaluation	Percentage	86%	86.02%	86%

Own compilation, using the following source: PTT Global Chemical PCL: Integrated Sustainability Report 2015, p. 48
http://www.pttgcgroup.com/src/download/sustain/20161006-pttgc-isr-2015.pdf

Furthermore, "PTTGC has set **product design criteria** that respond to the environment stewardship; e.g. environmental impacts of product manufacturing for new process technology, and reduction of hazardous materials for product development. PTTGC plans to study Life Cycle Management (LCM) in 2016. This project including environmental impact assessment throughout life cycle of polymer product (cradle-to-grave), product eco-efficiency, eco-design for polymers, and revise proactive environmental management for PTTGC Group. Eco-design study aims to imply the eco-design for polymers. Then, the eco-design guideline of plastic pellets will be developed and expanded to other products in PTTGC Group."

Measuring sustainability progress in the Sustainable Supply Chain

PTTGC has selected four criteria (metrics) for measuring its sustainability progress in relation to its sustainability targets for the Sustainable Supply Chain. Table 62 shows the corresponding sustainability targets.

Table 62: PTTGC: 2015 Sustainability Targets: Sustainable Supply Chain

Focus area	Metrics	Target 2015	Status 2015	Target 2016
1. Customer satisfaction	Score	> 84.6	88.6	> 88.6
2. Supplier satisfaction	Percentage	> 80%	91.08%	> 80%
3. Key suppliers (high-risk tier 1 suppliers) assessed on environmental, social and corporate governance performance	Percentage	4%	4%	4%
4. Suppliers receive yearly performance evaluations	Number	383	383	>380

Own compilation, using the following source: PTT Global Chemical PCL: Integrated Sustainability Report 2015
http://www.pttgcgroup.com/src/download/sustain/20161006-pttgc-isr-2015.pdf

Supply Chain Management Strategy

"PTTGC is aware of and places high priority in embedding ESG[220] into business practices and the corporate mind-set. A variety of initiatives are implemented in parallel with long-term large scale programs to assist employees in developing organizational capability and behavioral transformation, by incrementally embedding ESG in each personnel role and responsibility. **PTTGC has expanded sus-**

[220] Environmental, Social and Governance issues, see e.g. Table 78, page 155

tainability aspects as a part of team KPIs in core business practices to ensure that BUs delivers tangible ESG-results i.e. green procurement, operational efficiency, and effective CSR programs. By this strategy, cumulative team efforts should result in the recognition of PTTGC's sustainability performance by international rating agencies – a Corporate KPI."

Measuring sustainability progress in Operational Responsibility

PTTGC has selected six criteria (metrics) for measuring its sustainability progress in relation to its sustainability targets in Operational Responsibility. Table 65 shows the corresponding sustainability targets.

Table 63: PTTGC: 2015 Sustainability Targets: Operational Responsibility

Focus area	Metrics	Target 2015	Status 2015	Target 2016 (2020)
Responsible Environmental Management				
1. Water management by recycling water	Percentage	35%	36.8%	40%
2. Waste reduction	Tons	Zero waste to landfill	Zero waste to landfill	Continuity of zero waste to landfill
3. GHG emissions	Tons CO_2eq.	76,000	83,000	76,000
4. Efficient energy use at 1st quartile	Number of plants	15	10	10
5. TRIR: Total Recordable Injuries Rate	Cases per 1 million manhours	≤1.80	0.37	0.60
6. LTIFR: Lost Time Injuries Frequency Rate	Cases per 1 million manhours	0	0.09	0

Own compilation, using the following source: PTT Global Chemical PCL: Integrated Sustainability Report 2015 http://www.pttgcgroup.com/src/download/sustain/20161006-pttgc-isr-2015.pdf

In addition, PTTGC has set further goals for health and safety and for reducing natural resources use as well as greenhouse gas emissions by all companies in the Group, including

- A reduction of the Lost Time Injuries Frequency Rate (LTIFR) of employees and contractors to zero by 2020
- A reduction of Tier 1 Process Safety Events to zero by 2020
- A reduction of energy index under business as usual scenarios by 10% in 2020, from 2015 base year
- A reduction of GHG emissions by 10% by 2022, from 2013 base year, based on business as usual scenarios
- A reduction of water intensity, waste generation intensity and air emission intensity, VOC, NO_x and SO_2 by 10% each by 2023, from 2013 base year, based on business as usual scenarios

For enforcement, PTTGC has, amongst others implemented a new initiative entitled Environmental Management Accounting (EMA) following international guidelines on how to standardize spending categories and record systematically. Moreover, PTTGC has initiated the **Environmental Return on Investment (EROI) Project** to improve the effectiveness of a company's EMS financial reporting capabilities and return on environmental investment.

Employee Readiness

"Human capital development not only ensures that the company has the appropriate skill set in order to execute the business strategy, but also improves talent attraction and retention, and employee motivation; and, as a result, productivity and the potential for innovation. …"

PTTGC has selected three criteria (metrics) for measuring its sustainability progress in relation to its sustainability targets in Employee Readiness. Table 64 shows the corresponding sustainability targets.

"PTTGC is currently developing a means of measuring the economic benefits of its employee development investments. For the ROI of a particular program, PTTGC considers analyzing training programs; however, the data collection is now during the development phase to support the assessment."

Table 64: PTTGC: 2015 Sustainability Targets: Employee Readiness

Focus area	Metrics	Target 2015	Status 2015	Target 2016 (2020)
1. Average training hours	Hours per person per year	54	44	44
2. Total expenses for employee training and development	Baht per person per year	30,000	18,220	20,000
3. Employee engagement survey results	Percent	80	85.76	80

Own compilation, using the following source: PTT Global Chemical PCL: Integrated Sustainability Report 2015 http://www.pttgcgroup.com/src/download/sustain/20161006-pttgc-isr-2015.pdf

Green chemicals products

"Green Chemicals products are biochemicals derived from plant and animal fats. Fatty alcohol used in the pharmaceutical, cosmetics and personal hygiene industry, and methyl ester, from natural raw materials, which is used as an ingredient in biodiesel as alternative chemicals, are two examples of such products. Green Chemicals also includes Bioplastic, the innovative products that are environmental friendly." "Green" in this case does not mean the twelve principles of "Green Chemistry" as developed by Anastas and Warner (1998) [221], but raw material of biogenic origin.

8.3.1.3 Organizational structure and implementation

Sustainability is integrated in management processes[214, 222]:

- "PTTGC has a **Board Committee** formally responsible for governing sustainability in the organization, overseeing policy, strategy, and work plans which align with the company's targets and international standards."[222]
  "Importance is placed on the business operations with responsibility towards society and the environment, as well as on promoting the well-being and sustainability of Thai society. This starts with improving living standards of communities around PTTGC's plants, fostering an environment where PTTGC's plants and these communities can co-exist." [214]
- There are four **Board Committees**: Audit Committee, Corporate Governance Committee, Nomination and Remuneration Committee, Risk Management Committee.

[221] Anastas, P. T. / Warner, J. C. (1998): Green Chemistry: Theory and Practice. In: Oxford University press.

[222] http://www.pttgcgroup.com/en/sustainability/sustainability

- The role of the **Corporate Governance Committee** is to monitor and control overall performance in order to ensure that corporate sustainable development goals and continuous improvements are achieved.[223]
- "The **Sustainable Development Committee (SDC)** acts as a working group dealing with implementation of sustainability initiatives; ensuring that the plans are in alignment with PTTGC's goals and international standards; sustainability management for PTTGC Group Companies; supporting other departments in adhering to the sustainability policy; and as a focal point for collaboration with other parties." [222]
- "The **SDC Charter** mandates that the Committee reports progress on implementation of sustainable development directly and periodically to the Chairman of the Board of Directors, and the Board. The SDC consists of 11 members comprising Senior Vice Presidents (SVP) and other senior management executives from each business unit and function." [222]
- A function called **Corporate Sustainability Management (C-SM)** is responsible for formulating policy, frameworks and strategies for sustainable development. C-SM's roles also include, amongst others, performance monitoring and evaluation.
- There are different **management systems** in operation[224]. PTTGC employs an environmental management system which conforms to the ISO 14001:2004 standard as a fundamental standard in its operations.

8.3.1.4 Evaluation

PTTGC provides no explicit definition of sustainable chemistry, but sustainability is understood in accordance with the triple bottom line approach (economy, social and the environment). It has published (and is therefore committed to) almost 20 short-term (2016) and several mid-term sustainability targets (2022/2023) that are partly very ambitious (e.g. zero injuries and safety events). The inclusion of impact goals and indicators such as "keeping in the Top 10% of DJSI World Indices" is challenging, because the company can steer this only indirectly by its performance and the result also depends on how competitors' performance develops.

The SDGs are allocated to the company's materiality analysis in the 2015 Report (p. 25-28). [215]

Table 65 provides an overview of the main criteria for the evaluation of the company's sustainability approach.

Table 65: PTTGC: Evaluation of sustainability approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of sustainable chemistry, but sustainability is understood in accordance with the triple bottom line approach (economic, social, environmental). Globally applicable to chemical companies.
Consistency of indicator concept and how it is monitored	Not only performance but impact goals and indicators (2025) too: ► Position in Dow Jones Sustainability Indices (DJSI) ► Customer and supplier satisfaction.
Role of SDGs in the concept	Allocated to the company's materiality analysis. [215]
Probability of implementation	The inclusion of impact goals and indicators such as "keeping in the Top 10% of DJSI World Indices" is challenging, because the company can steer this only indirectly by its performance, and the result also depends on how competitors' performance develops.

[223] PTTGC: Annual Report 2014. http://pttgc.listedcompany.com/misc/AR/20150306-pttgc-ar2014-en-02.pdf

[224] http://www.pttgcgroup.com/en/sustainability/sustainability-policy

Subject	Comment
Overall impression	Ambitious.

Source: Own compilation

8.3.2 Sinopec Corp.

China Petrochemical Corporation (**Sinopec Group,** www.sinopecgroup.com) is a very large petroleum and petrochemical corporate group, established in July 1998 on the basis of the former China Petrochemical Corporation. Sinopec Group is a state-owned company where the state is the sole investor. It is run as a state-authorized investment organization in which the state holds the controlling share. Sinopec Group ranked third in the Fortune Global 500 in 2014.

China Petroleum and Chemical Company (**Sinopec Corp.**, http://english.sinopec.com), controlled by Sinopec Group, issued H-shares and A-shares overseas and at home in October 2000 and August 2001 respectively and was listed on stock markets in Hong Kong, New York, London and Shanghai. [225]

8.3.2.1 Sustainability approach

Sinopec Corp. is currently not ranked in the chemicals sector as rated by RobecoSAM (see Table 76). Table 66 provides an overview of the company and its sustainability approach, mainly based on Sinopec Corp. Annual Report 2015[226], and its Communication on Progress for Sustainable Development 2015[227]. Further information has been sourced from the Sinopec Group's Social Responsibility Report 2015[228], which is referencing amongst others the Global Report Initiative's (GRI) Sustainability Reporting Guidleines (Version 4.0) and contains a GRI index.

Table 66: Sinopec Corp.: Short Characterization

Subject	Information
Name/title	Sinopec Corp.
URL(s)	http://english.sinopec.com
Country (head office)	Beijing, China
Branches	76 countries (Sinopec Group) [228]
Products, market	"Sinopec Corp. is the largest manufacturer and distributor of petrochemicals in China with petrochemical production sites located throughout China's eastern, central and southern areas …. It produces and distributes a great variety of petrochemical products, including intermediates, synthetic resin, synthetic fiber monomers and polymers, synthetic fiber, synthetic rubber and chemical fertilizer, etc. The Company integrates its petrochemical production with its refining business. Chemical feedstock (e.g. naphtha) is mainly supplied by the Company's refineries. The Company distributes most of its petrochemical products in domestic market." [229]

[225] http://www.sinopecgroup.com/group/en/companyprofile/AboutSinopecGroup/

[226] Sinopec Corp. 2015 Annual Report and Accounts. http://english.sinopec.com/download_center/reports/2015/20160329/download/2016032918C.pdf

[227] Sinopec Corp. 2015 Communication on Progress for Sustainable Development. http://english.sinopec.com/download_center/reports/2015/20160329/download/20160329001en.pdf

[228] China Petrochemical Corporation Social Responsibility Report 2015 http://www.sinopecgroup.com/group/en/Resource/pdf/ResponsibilityReport_2015_en.pdf

[229] http://english.sinopec.com/about_sinopec/our_business/chemical/

Subject	Information
Economic KPIs	RMB billion 2,019 revenue RMB billion 32.21 net profits attributable to shareholders
Employees	~351,000
Ratings	"Sinopec Group with Sinopec Corp. as its core assets, advanced to No. 2 in Fortune 500 Companies." [227]
Mission	2014: Sinopec chose "fueling a better life" as the enterprise mission, "building people-oriented, world first-class energy and chemical company" as the vision, and "people, responsibility, integrity, precision, innovation and shared values" as the core value.
Principles/values	2014: People, responsibility, integrity, precision, innovation and shared values 2015: "Meanwhile, we upheld the philosophy of "Building the enterprise as employees' family" to advocate the common expectations and build a more cohesive enterprise." [227] Commitment to the ten principles of the UN Global Compact
Strategy	Green and low-carbon development strategy
CSR report	Sustainability Report, non-GRI; 2013 Communication on Progress for Sustainable Development[230] was the last CoP referencing GRI Sustainability Reporting Guidelines (but without GRI index)
Definition of sustainable chemistry OR sustainability	No definition.
Concept of selected indicators	Selected indicators for classic environmental protection/emission reduction comparable to that asked for by GRI. No sustainability goals
Launch year, change in concept (if any) since then	n.a.
Instruments and measures for implementation	n.a.
Status of implementation (e.g. description of best practice etc.)	For selected aspects of environmental protection, e.g. use of municipal reclaimed water and desalinated water as supplement of circulating water
Status and type of monitoring including e.g. time series of indicator measurements	Annual Communication on Progress for Sustainable Development
Stakeholder engagement	Within development of substantial issue analysis matrix
Additional information	Honours in 2015: ► Sinopec's Energy Conservation Plan was awarded Top 10 Green Actions of Chinese Enterprises granted by UNGC Network China ► Sinopec's Clean Water and Blue Sky Campaign was awarded Enterprise with Best Environmental Responsibility at the 2015 China Environmental Protection Summit Forum

[230] Sinopec Corp. 2013 Communication on Progress for Sustainable Development. http://www.sinopecgroup.com/group/en/Resource/pdf//2013032523.pdf

Subject	Information
	► China Model of Low-Carbon Development 2015 by China News Service and China Newsweek for five consecutive years

Own compilation, using the following sources: Sinopec Corp. 2015 Annual Report and Accounts, and Sinopec Corp. 2015 Communication on Progress for Sustainable Development
http://english.sinopec.com/download_center/reports/2015/20160329/download/2016032918C.pdf
http://english.sinopec.com/download_center/reports/2015/20160329/download/20160329001en.pdf

8.3.2.2 Criteria

Though Sinopec Corp.'s 2015 Communication on Progress for Sustainable Development does not include what is referred to as a sustainability programme, criteria for sustainable development can be deduced.

Under the heading "Responsibility Creates Value", three aspects are addressed here: Creating economic value, promoting social value and enriching cultural value, see Table 67. The criteria are comparable to those asked for by GRI.

Table 67: Sinopec Corp.: Criteria and the metrics for Creating Value [227]

Goal	Criteria
Creating economic value	► Total assets (RMB billion) ► Revenue (RMB billion) ► Net profit (RMB billion) ► Dividends declared to shareholders (RMB billion) (accretive) ► Taxes and fees paid (RMB billion) ► % of the country's total cumulative revenues
Promoting social value	► Collective contract and social insurance coverage (%) ► Employee health check-up coverage (%) ► Annual average growth of gross industrial output value of the company (%) ► Rate of increase of total energy consumption (%) ► Decrease of company's energy intensity (%) ► Decrease of industrial water consumption (%) ► Company performance vs. state requirements during the 12th Five-Year Plan period ► Reduction in COD (chemical oxygen demand) emissions ► Reduction in SO_2 emissions ► Reduction in ammonia nitrogen emissions ► Reduction in nitrogen oxides emissions ► Accumulated donations to society since IPO (= entry to stock exchange) (RMB) ► Number of patients cured under the Lifeline Express Programme (a charity project) since IPO
Enriching cultural value	► Accumulated contributions to cultural education, community development and medical service (RMB) since IPO

Own compilation, using the following source: Sinopec 2015 Communication on Progress for Sustainable Development; further KPIs an pages 52-54
http://english.sinopec.com/download_center/reports/2015/20160329/download/2016032918C.pdf

There are no criteria which especially address green or sustainable chemistry. Under the heading "**Green** is the prerequisite for sustainable development", the company points out: "Sinopec Corp. is endeavouring to avoid, minimise and mitigate environmental impacts wherever and whenever we do business. We adhere

to our **green and low-carbon development strategy**, and fulfil our environmental responsibility by strengthening environmental management, providing clean energy, conserving energy and reducing emission, and responding to climate change. We strive to build an energy-saving and environmentally friendly enterprise, contributing to the harmonious development between human and nature."

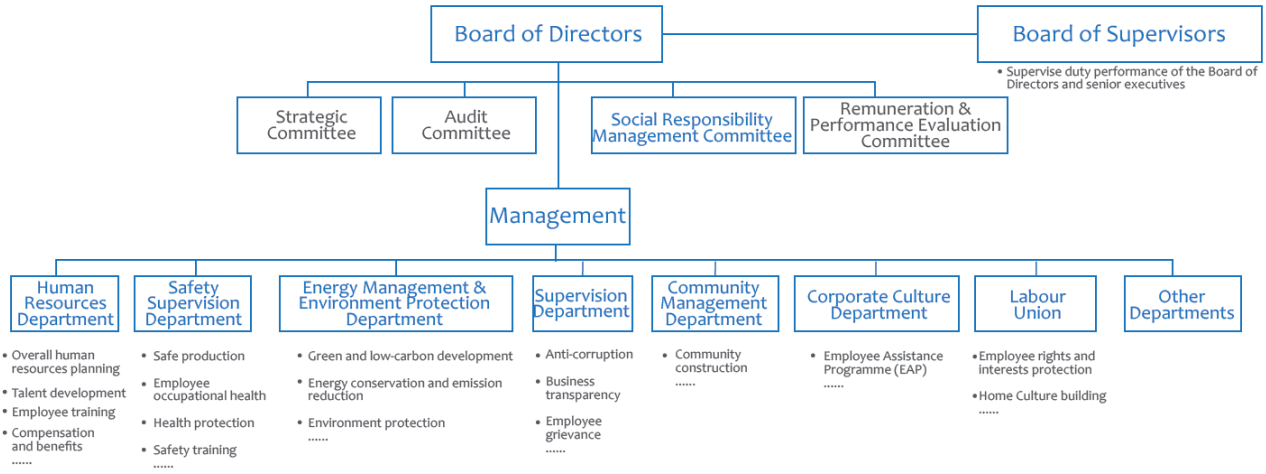
"Green" in this case does not mean the twelve principles of "Green Chemistry" as developed by Anastas and Warner (1998) [231], but classic environmental protection/emission reduction.

8.3.2.3 Organizational structure and implementation

In order to improve the relevance and responsiveness of its 2015 Communication on Progress for Sustainable Development, Sinopec Corp. conducted a sustainable development substantial issue analysis survey among internal and external stakeholders, including government agencies, investors, partners, employees, consumers, non-governmental organizations and media. Using the survey's results, the company created a substantial issue analysis (= materiality) matrix based on the following two dimensions of "impact on Sinopec's sustainable development" and "importance to stakeholders", and prioritized the issues. One of the issues with the (second) highest score from both dimensions was "Sustainable development management".

Figure 7 shows Sinopec Corp.'s Governance Structure of Sustainable Development. Further information, e.g. on supporting measures (e.g. incentives), is not available.

Figure 7: Sinopec Corp.: Governance Structure of Sustainable Development[227]



Source: Sinopec Corp. 2015 Communication on Progress for Sustainable Development.
http://english.sinopec.com/download_center/reports/2015/20160329/download/20160329001en.pdf

"Sinopec Corp. set up the **Social Responsibility Management Committee of the Board of Directors** in 2012, responsible for corporate social responsibility management strategies and plans, and the annual social responsibility planning, and for making recommendations to the Board. In May 2015, the Company's shareholders' meeting elected the 6th Session of the Board of Directors, and re-appointed the members of the Social Responsibility Management Committee. The committee consists of Chairman Wang Yupu, director and President Li Chunguang, and independent director Tang Min. The committee adheres to the green and low-carbon development strategy and advance Sinopec's sustainable development." [227]

8.3.2.4 Evaluation

Sinopec Corp.'s green and low-carbon development strategy focuses on classic emission reduction (green) and energy saving (low carbon). There is neither a link to green chemistry principles nor to the SDGs. Table 68 provides an overview of the main criteria for the evaluation of the company's sustainability approach.

[231] Anastas, P. T. / Warner, J. C. (1998): Green Chemistry: Theory and Practice. In: Oxford University press.

Table 68: Sinopec Corp.: Evaluation of sustainability approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No definition.
Consistency of indicator concept and how it is monitored	Selected indicators for classic environmental protection/emission reduction comparable to that asked for by GRI. No sustainability goals.
Role of SDGs in the concept	None
Probability of implementation	n.a.
Overall impression	Too little information.

Source: Own compilation

8.4 Interim conclusion on approaches at company level

The evaluation of the approach of six chemical companies – all global players – shows that only one (Dow Chemical) has a clear understanding and definition of sustainable chemistry: “With more than 95 percent of all manufactured goods relying on chemistry in their value chain, integrating sustainability and green chemistry concepts – "sustainable chemistry" – as a building block is a vitally important part of building a more sustainable economy. Green chemistry is a set of principles to design, but **sustainable chemistry** looks beyond only a science. It is a catalyst for change, an innovative approach to problem-solving and a long-term solution to global sustainability challenges. … Ultimately, chemistry and collaboration – and people – have the power to bend that straight line to a more positive point in the future, where nature and therefore human prosperity are in balance.”

With regard to sustainability, the other companies refer mainly to the triplebottom line approach (social, economic and environmental, “three dimensions”, “three pillars”).

Five of the six companies have published a Sustainability/CSR report (or integrated report) in accordance with GRI guidelines. The concept of indicators, criteria and metrics for reporting is therefore f. However, companies are allowed to use additional metrics to control their sustainability goals.

- AkzoNobel uses additional metrics such as eco-premium solutions with downstream benefits
- DSM uses additional metrics such as Eco+ and People+ solutions with downstream benefits
- Dow uses additional metrics such as Breakthrough: Evaluation of innovations for their impact on alleviating world challenges (energy and climate change, water, food, housing and health), measured level of support among key value chain and stakeholder representatives and sum of people whose sustainable development challenges have been positively impacted
- PTTGC uses societal impact indicators such as position in Dow Jones Sustainability Indices (DJSI) and customer and supplier satisfaction.

These are interesting approaches. It is recommended that the evaluation of chemical company approaches is continued and the new indicators and metrics used are systemized.

9 Approaches in sustainability reporting, sustainability rating and socially responsible investment

9.1 Approaches in sustainability reporting

There are different approaches for (corporate) sustainability reporting or integrated reporting (e.g. Global Reporting Initiative, International Integrated Reporting Committee (IIRC), Climate Disclosure Standards Board, Sustainability Accounting Standards Board (SASB)). In the following section, two of these approaches – GRI and SASB – are described in more detail with regard to reporting on sustainable chemistry.

9.1.1 Global Reporting Initiative (GRI)

9.1.1.1 Background

The Agenda 21 was adopted at the United Nations' Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Chapter 30 – Strengthening The Role Of Business And Industry – asked business and industry (clause 30.10)

(a) to report annually on their environmental records, as well as on their use of energy and natural resources;

(b) to adopt and report on the implementation of codes of conduct promoting the best environmental practice, such as the Business Charter on Sustainable Development of the International Chamber of Commerce (ICC) and the chemical industry's Responsible Care initiative.

To harmonize reporting requirements, the Coalition of Environmentally Responsible Economies (CERES) in partnership with the UN Environment Programme UNEP established the Global Reporting Initiative (GRI) in 1997. Since then, the GRI reporting guidelines have established themselves as the leading standard for corporate sustainability (or corporate social responsibility (CSR)) reporting. In 2010, GRI and the UN Global Compact started working together and a set of indicators or the ten principles of the UN Global Compact has been included in the GRI standards. At present (August 2016), more than 9,400 organisations and over 24,000 GRI reports are listed in the GRI database[232].

In May 2013, GRI introduced the fourth generation of its standards (G4) for sustainability reporting[233]. Sustainability reports shall now focus on those aspects that are material[234], which "reflect the organization's significant economic, environmental, or social impacts, or substantially influence the assessments and decisions of stakeholders". A company must now concentrate on the essentials for its supply chain information: On the economy, environment, working conditions, human rights, society and product responsibility. For example, some new indicators are included for the assessment of suppliers with regard to their responses to environmental, human rights, labour relations and societal issues. A company must now also explain how it manages its material aspects by an illustration of its Disclosures on Management Approach (DMA). "In particular, the Disclosures on Management Approach (DMA) show whether and how a company is seriously striving to evolve as the company has to explain "how it is managing its material economic, environmental or social impacts (Aspects), thus providing an overview of its approach to sustainability issues".[235]

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[232] http://database.globalreporting.org

[233] GRI G4: Sustainability Reporting Guidelines, Part 1: Reporting Principles and Standard Disclosures. https://www.globalreporting.org/resourcelibrary/GRIG4-Part1-Reporting-Principles-and-Standard-Disclosures.pdf
GRI G4: Sustainability Reporting Guidelines, Part 2: Implementation Manual. https://www.globalreporting.org/resourcelibrary/GRIG4-Part2-Implementation-Manual.pdf

[234] „Organizations are faced with a wide range of topics on which they could report. Relevant topics are those that may reasonably be considered important for reflecting the organization's economic, environmental and social impacts, or influencing the decisions of stakeholders, and, therefore, potentially merit inclusion in the report. Materiality is the threshold at which Aspects become sufficiently important that they should be reported." https://g4.globalreporting.org/how-you-should-report/reporting-principles/principles-for-defining-report-content/materiality/Pages/default.aspx

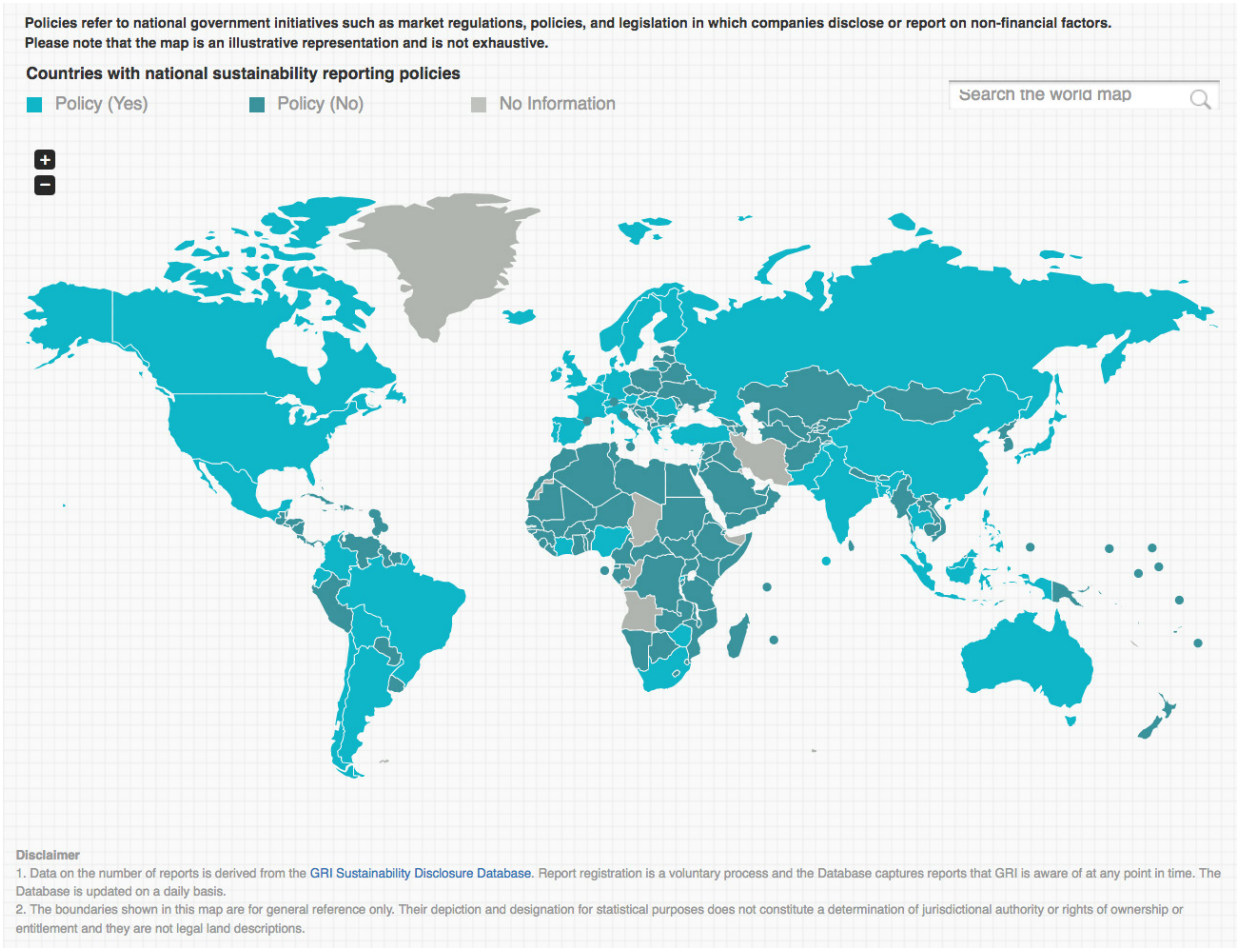
[235] GRI: An introduction to G4. The next generation of sustainability reporting. https://www.globalreporting.org/resourcelibrary/GRI-An-introduction-to-G4.pdf

The DMA can be used as a valuable source of information on how chemical companies are preparing for the future.

Sustainability reporting is directly linked to SDG 12.6: "Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle."

In many countries, national government initiatives already exist, such as market regulations, policies and legislation in the framework of which companies disclose or report on non-financial factors, in the absence of legal obligations also on a voluntary basis. A matrix of sustainability reporting policies and initiatives in 45 countries and regions is available in the "Carrots and Sticks 2013" report by UNEP, GRI, KPMG and The Centre for Corporate Governance in Africa.[236] In the European Union, the reporting of non-financial and diversity data – externally verified – will become mandatory for certain large enterprises and groups starting with the 2017 fiscal year[237].

Figure 8: Countries with national sustainability reporting policies (August 2016)



Source: Global Reporting Initiative (GRI): http://database.globalreporting.org/SDG-12-6/Global-Tracker, 29.08.2016

[236] UNEP, GRI, KPMG and The Centre for Corporate Governance in Africa: CARROTS AND STICKS. Sustainability reporting policies worldwide – today's best practice, tomorrow's trends. 2013 edition. http://www.materialitytracker.net/wp-content/uploads/2015/03/Carrots-Sticks-III-2013.pdf

[237] DIRECTIVE 2014/95/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups. Official Journal of the European Union L 330/1, 15.11.2014 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0095&from=EN

In addition, stock exchanges around the world are invited to join the UN Sustainable Stock Exchanges (SSE) initiative by signing a voluntary public commitment to promote sustainable business practices in their market.[238] One instrument amongst these practices is reporting on environmental, social and governance (ESG) issues to shareholders. "The spectrum of company approaches to reporting on ESG information is rapidly evolving. While there is no one-size-fits-all method, there are emerging international and local best practices, guidelines and frameworks. Building on these existing resources, the United Nations Sustainable Stock Exchanges (SSE) initiative developed the Model Reporting Guidance … to assist exchanges in providing their own voluntary guidance to issuers that are starting or furthering their reporting journey. Exchanges led its development with a multi-stakeholder advisory group composed of investors, companies and other subject matter experts."[239] SSE's Model Reporting Guidance[240] refers on several occasions to the GRI reporting guidelines as well as to SASB standards (see section 9.1.2).

9.1.1.2 Characterization

Table 69: Global Reporting Initiative: Short Characterization[241]

Subject	Information
Name/title	Global Reporting Initiative
URL	www.globalreporting.org
Type of organisation	International independent organization
Coverage/region	Global
Institution(s) behind initiative/approach	Its roots lie in US non-profit organizations, i.e. the Coalition for Environmentally Responsible Economies (CERES) and the Tellus Institute.
Legal information	"GRI is a non-profit foundation – in Dutch: stichting – with a business model that aims for a degree of self-sufficiency. Funding is secured from diverse sources; governments, companies, foundations, partner organizations and supporters." "GRI is an international independent organization with a network-based structure; and a Collaborating Centre of the United Nations Environment Programme."
Governance bodies	"The appointment of GRI's governance body members is overseen by two committees, the GRI Nominating Committee (GNC) and the Independent Appointments Committee (IAC). The GRI Nominating Committee is responsible for appointments to the GRI Board of Directors and the Stakeholder Council. Together with external individuals the GNC forms an extended GRI Nominating Committee for appointments to the Independent Appointments Committee. The Independent Appointments Committee is responsible for appointments to the standards-related governance bodies, i.e. the **Global Sustainability Standards Board** and the Due Process Oversight Committee. The Independent Appointments Committee is currently in the process of appointing members to the inaugural Due Process Oversight Com-

[238] http://www.sseinitiative.org/about/

[239] SSE Initiative: Model Guidance on Reporting ESG Information to Investors: A Voluntary Tool For Stock Exchanges to Guide Issuers, 2015. http://www.sseinitiative.org/wp-content/uploads/2015/10/SSE-Model-Guidance-on-Reporting-ESG.pdf

[240] http://www.sseinitiative.org/wp-content/uploads/2015/10/SSE-Model-Guidance-on-Reporting-ESG.pdf

[241] https://www.globalreporting.org

Subject	Information
	mittee."
President/CEO/Chairman	Eric Hespenheide, retired Deloitte & Touche LLP Partner, is GRI's Interim Chief Executive and also serves on the GRI Board of Directors. He previously chaired the Global Sustainability Standards Board (GSSB).
Year of foundation	1997
Budget/funding	GRI is supported by a global network, and has diverse sources of funding. This means: ► Project grants from governments and foundations ► Corporate sponsorship of projects and events ► Provision of learning and other services ► Support from a large international community of members of the GRI GOLD Community and Stakeholder Council members https://www.globalreporting.org/information/FAQs/Pages/About-GRI.aspx
Links/closeness to other stakeholders	"The Stakeholder Council (SC) is the formal stakeholder policy forum within the GRI governance structure and advises the Board on strategic issues. The SC's key governance functions include appointing Board members and making recommendations on future policy, business planning and activity. Up to 50 members sit on the Stakeholder Council. Its membership is diverse and drawn from all United Nations-defined regions: Africa, Asia Pacific/Oceania, Latin America/Caribbean, North America/Europe/CIS and West Asia. Its members represent core stakeholders in GRI's network: Business, civil society organizations, investment institutions, labour and mediating institutions."
Target audience and sectoral/geographical scope	"Sustainability reporting is carried out by companies and organizations of all types, sizes and sectors. Of the world's largest 250 corporations, 93 % report on their sustainability performance and 82 % of these use GRI's standards to do so."
Self-declared goal	"Our vision is to create a future where sustainability is integral to every organization's decision-making process. Our mission is to empower decision makers everywhere, through our sustainability standards and multi-stakeholder network, to take action towards a more sustainable economy and world. We believe: ► In the power of a multi-stakeholder process and inclusive network ► Transparency is a catalyst for change ► Our standards empower informed decision making ► A global perspective is needed to change the world ► Public interest should drive every decision an organization makes"
Definition of sustainable chemistry OR sustainability	No explicit definition: "GRI is the bridge between businesses and governments, enabling them both to make positive contributions to the UN SDGs."
Concept of selected indicators	**Strong focus on environmental, social and governance (ESG) issues** **Organizations are only required to provide indicators on aspects that they and their stakeholders have identified as important to the business.** G4 contains indicators for a wide range of environmental,

Subject	Information
	social and governance (ESG) issues. For example, they include GHG emissions, health and safety, human rights or an organization's impact on local communities.
Launch year, change in concept (if any) since then	► 2006: G.3 guideline ► 2011: G3.11 guideline ► 2013: G4 Guidelines ► 2016: GRI Sustainability Reporting Standard (SRS) published (2016-10-19)[242] ► 01.01.2018: Entry into force of GRI standards ► 01.07.2018: Use of GRI SRS is mandatory
Proposed instruments and measures for implementation	Materiality analysis (in cooperation with stakeholders), standardized reporting on material (relevant) aspects and (quantified) key indicators on output and impact; periodic progress report
Status of implementation (e.g. description of best practice etc.)	"GRI has pioneered sustainability reporting since the late 1990s, transforming it from a niche practice into one now adopted by a growing majority of organizations. The GRI Standards for Sustainability Reporting are now "the most trusted and widely used standards for sustainability reporting" in the world. See sub-section 9.1.1.3. In the EU, GRI guidelines are a reporting framework accepted by directive 2014/95/EU[237]. GRI itself does not publish rankings or best practice examples, but other experts do, e.g. ► 2016: EY's Excellence in Integrated Reporting. Awards 2016. A survey of integrated reports from South Africa's top 100 JSE listed companies and top ten state-owned companies. http://integratedreporting.org/wp-content/uploads/2016/08/EYs-Excellence-in-Integrated-Reporting-2016_final_Web.pdf ► 2005: German Ranking of Sustainability Reports[243]
Status and type of monitoring including e.g. timeline of indicator measurements	Companies can decide how often they publish a report (annual, biennial, …) and whether they include a review by an external, independent verifier/auditor.
Stakeholder engagement	**Development of G4 guidelines:** Multi-stakeholder input: "Our approach is based on multi-stakeholder engagement, representing the best combination of technical expertise and diversity of experience to address the needs of all report makers and users. This approach enables us to produce universally-applicable reporting guidance. All elements of the Reporting Framework are created and improved using a consensus-seeking approach, and considering the widest possible range of stakeholder interests which includes business, civil society, labour, accounting, investors, academics, governments and sustainability reporting practitioners." **Sustainability Report:** Stakeholder Inclusiveness is one of the four principles for defining report content (the others are Materiality,

[242] https://www.globalreporting.org/standards/gri-standards-download-center/

[243] Gebauer, Jana; Hoffmann, Esther: Evaluating Extra-Financial Reporting: The Case of the German Ranking of Sustainability Reports. Journal of Applied Accounting research, Vol. 10, No. 3 (2009), pp. 224–234. http://www.emeraldinsight.com/doi/pdfplus/10.1108/09675420911006424

Subject	Information
	Sustainability Context and Completeness). (GRI-G4, Part 2, p. 32 et seq.)
Additional information	► GRI indicators have been used e.g. for an annual series that tracks the extent to which the world's publicly traded companies are disclosing the seven "first-generation" sustainability indicators, namely: Employee turnover, energy, greenhouse gas emissions (GHGs), injury rate, payroll, waste and water. ► 2016: Corporate Knights. Measuring Sustainability Disclosure. Ranking the World's Stock Exchanges http://www.sseinitiative.org/wp-content/uploads/2016/07/SSE2016Final.pdf

Own compilation, using the following source: GRI website https://www.globalreporting.org

9.1.1.3 Application in the chemical sector

According to GRI-G4, the report must include:

1. **General Standard Disclosures**: "These disclosures set the overall context for the report, providing a description of the organization and its reporting process." [244] Included is a list of almost 60 indicators to be reported within the following sections:

- Strategy & Analysis
- Organizational Profile
- Identified Material Aspects & Boundaries
- Stakeholder Engagement
- Report Profile
- Governance
- Ethics & Integrity

The company can decide whether it reports at core or comprehensive level. The latter includes more indicators on strategy and analysis, governance, and ethics and integrity than the core level.

2. **Specific Standard Disclosures**[245]: These are divided into two areas:

- "The **Disclosures on Management Approach (DMA)** gives the organization an opportunity to explain how it is managing its material economic, environmental or social impacts (Aspects), thus providing an overview of its approach to sustainability issues. The DMA focus on three things: Describing why an aspect is material, how its impacts are being managed, and how the approach to managing this aspect is being evaluated.
- **Indicators** allow companies to provide comparable information on their economic, environmental and social impacts and performance. Much of this is in the form of quantitative data. **Organizations are only required to provide indicators on Aspects that they and their stakeholders have identified as material to the business**."[244]
  - Option "core": At least one indicator related to each identified material aspect has to be reported.
  - Option "comprehensive": All indicators related to each identified material aspect have to be reported.

[244] GRI: An introduction to G4. The next generation of sustainability reporting. https://www.globalreporting.org/resourcelibrary/GRI-An-introduction-to-G4.pdf

[245] GRI offers sector disclosures e.g. for the oil and gas or the mining and metals sector, but not for the chemical sector. https://www.globalreporting.org/standards/sector-guidance/sectorguidanceG4/Pages/default.aspx

- G4 contains indicators for a wide range of sustainability issues from different categories. A list of the specific standard disclosures indicators for each aspect is shown in sub-chapter 14.4. They include amongst others:
  - Category: Economic; e.g.
    - Procurement practices: G4-EC9 Local suppliers
  - Category: Environmental, e.g.
    - Materials: G4-EN1 Materials by weight or volume (by non-renewable and renewable), G4-EN2 Recycled input materials
    - Energy: G4-EN3 Energy consumption (Scope 1 + 2), G4-EN4 Energy consumption (Scope 3), G4-EN5 Energy intensity, G4-EN6 Energy reductions, G4-EN7Energy reductions in products and services
    - Water: G4-EN8 Water withdrawals by source. G4-EN9 Water sources affected by withdrawals (including biodiversity), G4-EN10 Water recycled and reused
    - Biodiversity: G4-EN11 Facilities in or near areas of high diversity, G4-EN12 Impacts on biodiversity, G4-EN13 Habitats protected or restored, G4-EN14 IUCN Red List species
    - Emissions[246]: G4-EN15 Direct GHG emissions (Scope 1), G4-EN16 Indirect GHG emissions (Scope 2), G4-EN17 Other indirect GHG emissions (Scope 3), G4-EN21 NO_x, SO_x and other emissions
    - Supplier Environmental Management: G4-EN33 Significant actual and potential negative environmental impacts in the supply chain and actions taken
  - Category: Social
    - Sub-category: Labour Practices & Decent Work, e.g. G4-LA6 Rates of injury, occupational disease, lost days, absenteeism, and work-related fatalities, G4-LA14 New suppliers that were screened using labour practices criteria
    - Sub-category: Human Rights, e.g. G4-HR10 New suppliers screened for human rights, G4-HR11 Human rights impacts in the supply chain
    - Sub-category: Society, e.g. G4-SO5 Confirmed incidents of corruption, G4-SO6 Political contributions
    - Sub-category: Product Responsibility, e.g. G4-PR6 Sale of banned or disputed products, G4-PR9 Fines for non-compliance with laws and regulations concerning products and services

Companies are only required to provide indicators on aspects that they and their stakeholders have identified as material to their business, but in practice the materiality assessment of chemical companies will probably show the same ESG challenges with differing accentuation: Governance, workforce (safety and health, diversity and equality), environment (energy, emissions, waste), product responsibility (incl. supply chain), external stakeholders (e.g. communities in which the company operates) and organizational resilience. For these aspects, key performance indicators should be reported and targets set – both quantified, where possible – in order to make progress measurable.

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[246] The GHG Protocol defines direct and indirect emissions as follows: http://www.ghgprotocol.org/calculation-tools/faq

Direct GHG emissions are emissions from sources that are owned or controlled by the reporting entity.

Indirect GHG emissions are emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity.

The GHG Protocol further categorizes these direct and indirect emissions into three broad scopes:

Scope 1: All direct GHG emissions.

Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.

Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g. T&D losses) not covered in Scope 2, outsourced activities, waste disposal, etc.

In August 2016, the GRI database listed about 130 GRI (stand alone or integrated) reports or references in accordance with G4, published in 2015 or later by companies in the chemical sector throughout the world. Of these over 50 reports are by Taiwanese companies. No corresponding matches were found for Africa. In the tables in the Annex, current reports have been added which are already available on the companies' websites but are not yet included in the GRI database. "Undeclared" reports are also included, i.e. when no explicit 'in accordance' option is declared but the report contains a complete G4 Content Index.

Table 70: Sustainability/CSR reports in accordance with GRI-G4 by chemical companies (n=), published in 2015/16 (non-exhaustive list)

Region	Country	n = [a]	Region	Country	n = [a]
Asia	India	2	**Northern America**	United States of America	9
	Indonesia	1	**Europe**	Belgium	2
	Israel	1		Finland	2
	Japan	11		France	1
	Korea, Republic of	3		Germany	9
	Kuwait	2		Italy	1
	Pakistan	1		Netherlands	4
	Qatar	4		Norway	1
	Taiwan	**52**		Portugal	1
	Thailand	2		Russia	5
	United Arab Emirates	1		Sweden	1
Latin America and Caribbean	Argentina	2		Switzerland	4
	Brazil	5		United Kingdom	1
	Chile	2	**Oceania**	Australia	1 [b]
	Mexico	1	**Africa**	South Africa	None [c]

a) Reports with an "undeclared" status are included

b) Orica Ltd. is included here because it is a leading supplier of sodium cyanide for gold extraction. Overall it is the largest provider of commercial explosives and blasting systems to the mining, quarrying, oil and gas and construction markets and a global leader in the provision of ground support in mining and tunnelling.

c) Two with G.3/G.3.1 and one non-GRI

Own compilation, using the following source: http://database.globalreporting.org, August 2016

9.1.1.4 Evaluation

In many countries, sustainability reporting is not mandatory, especially for companies not listed on stock markets. The application of GRI guidelines is voluntary in most cases. In contrast to the financial data of the annual report, requirements for the reliability of non-financial data is currently low (no external verification by an accounting company required). A sustainability or CSR report in accordance with GRI G4 on the other hand offers information on how a chemical company works for progress to sustainability using standardized indicators. In particular, the Disclosures on Management Approach (DMA) shows whether and how a company is seriously striving to evolve as the company has to explain "how it is managing its material economic, environmental or social impacts (Aspects), thus providing an overview of its approach to sustainability issues". [244]

Table 71: Evaluation of the Global Reporting Initiative (GRI) approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of sustainable chemistry, but sustainability is understood in a comprehensive way (material economic, environmental and social impacts). Globally applicable to chemical companies.
Consistency of indicator concept and how it is monitored	Indicator concept is consistent with the approach when reporting is "comprehensive". Monitoring should be improved by making reporting and external verification by an accounting company mandatory (as is already the case for financial data).
Role of SDGs in the concept	► Strengthened by GRI G4: there is a direct link, see http://sdgcompass.org/wp-content/uploads/2015/09/SDG-Compass-Linking-the-SDGs-and-GRI.pdf ► In addition, in partnership with the UN Global Compact and the World Business Council for Sustainable Development, GRI co-created the SDG Compass, which will help businesses understand and contribute to the SDGs. https://www.globalreporting.org/information/policy/Pages/SDGs.aspx The following table links the Sustainable Development Goals (SDGs) to the indicators in the GRI G4 Sustainability Reporting Guidelines and Sector Disclosures. These linkages are based on a more detailed analysis available on the SDG Compass website (www.sdgcompass.org). http://sdgcompass.org/wp-content/uploads/2015/09/SDG-Compass-Linking-the-SDGs-and-GRI.pdf
Probability of implementation	"There is continued and growing interest in regulation, including corporate governance and disclosure requirements. We are also witnessing an increase in the number of countries becoming involved in the sustainability reporting policy arena, including developing countries. An increasing number of policies are inspired by or based on a 'report or explain' approach. … In addition to governments' efforts, sustainability reporting has become a listing requirement on several stock exchanges in non-OECD countries. Stock exchanges and market regulators are a strong force behind driving transparency and disclosure. … There will be a bigger audience for sustainability reports. This will be generated by research on companies' disclosure, data harvesting and elaboration, more critical company watching, greater use of sustainability rankings, and more 'naming and shaming' in order for markets and society to make informed decisions."[236]
Overall impression	Valuable concept with regard to several aspects of sustainable chemistry, such as workforce (safety and health, diversity and equality), environment (energy, emissions, waste), product responsibility (incl. supply chain). Should become mandatory for at least large and medium-sized companies.

Source: Own compilation

9.1.1.5 Synergies and complementarities

There are further recommendations for responsible business, e.g. the UN Global Compact, the OECD Guidelines for Multinational Enterprises, the United Nations Guiding Principles on Business and Human Rights (UNGP) or ISO 26000. "There are also a variety of single-issue principles and initiatives. Initiatives in place before 2010 include the International Labor Organization (ILO) Tri-partite Declara-

tion of Principles Concerning Multinational Enterprises and Social Policy, the Carbon Disclosure Project (CDP) questionnaire, the Greenhouse Gas Protocol, and the Principles for Responsible Investment Reporting Framework. …

The existing internationally-accepted sustainability and corporate responsibility frameworks have many synergies and complementarities. For example, the complementarity of the UNGC principles, the OECD Guidelines, ISO 26000 and GRI's Guidelines is acknowledged in the development approaches of all these organizations."[236]

With regard to synergies and complementarities of the approaches mentioned, a detailed analysis of the other approaches is not expedient.

9.1.2 Sustainability Accounting Standards Board (SASB)

9.1.2.1 Background

The Sustainability Accounting Standards Board sets industry-specific standards for corporate sustainability disclosure, with a view to ensuring that disclosure is material, comparable and aids investors's decision-making.[247]

"SASB, a non-profit US-based organisation, issues sustainability accounting standards that reporting issuers can use to disclose material sustainability information in filings with the Securities and Exchange Commission. SASB standards identify sustainability topics and related accounting metrics, at an industry level, that are likely to constitute material information to companies in that industry. Through the beginning of 2016, SASB is developing provisional standards for more than 80 industries in 10 sectors. SASB's standards development process includes evidence-based research, multi-stakeholder working groups, a 90-day public comment period, and a review by an independent standards council."[248]

9.1.2.2 Characterization

Table 72: Sustainability Accounting Standards Board (SASB): Short Characterization

Subject	Information
Name/title	Sustainability Accounting Standards Board (SASB)
URL	http://www.sasb.org
Type of organisation	Independent non-profit US-based organization
Coverage/region	United States
Institution(s) behind initiative/approach	The idea for SASB originated in 2010 in the framework of the Initiative for Responsible Investment (IRI) at Harvard University.[249] Further details: See Governance bodies: Standards Council and Standards Council Sub-Committee
Legal information	United States Code (USC) 26 § 501(c)3 non-profit organization
Governance bodies	Board of Directors Standards Council (independent), composed of experts in standards development, securities law, environmental law, metrics and accounting. [250]

[247] http://www.sasb.org/sasb/vision-mission/

[248] http://www.sseinitiative.org/wp-content/uploads/2015/10/SSE-Model-Guidance-on-Reporting-ESG.pdf

[249] http://www.sasb.org/wp-content/uploads/2016/02/BriefingBook_021716_web.pdf

Subject	Information
	Standards Council Sub-Committee [251]
President/CEO/Chairman	Chair of the Board: Michael R. Bloomberg, philanthropist, founder of Bloomberg LP, and 108th mayor of New York City [252]
Year of foundation	2011
Budget/funding	Bloomberg Philantrophies, F.B. Heron Foundation, TomKat Charitable Trust, Gordon and Betty Moore Foundation, Ford Foundation, pwc, The David & Lucile Packard Foundation, Deloitte, Rockefeller Foundation and other supporters[253]
Links/closeness to other stakeholders	Topics identified through stakeholder engagement, e.g. in the material transformation sector (including chemicals) [254]
Target audience and sectoral/geographical scope	SASB's approach focuses on US public equities and compatibility with US securities law. The standards are designed for disclosure in SEC filings. (SEC = US Securities and Exchange Commission).
Self-declared goal	SASB standards are designed for the disclosure of material sustainability information in mandatory SEC filings, such as Form 10-K and 20-F. [255] "89 % of global institutional investors will request sustainability information directly from companies, but only 10 % of companies are integrating sustainability metrics into 10-K filings." [256]
Definition of sustainable chemistry OR sustainability	No explicit definition of sustainable chemistry or sustainability. Sustainability disclosure topics and accounting metrics for the chemicals industry, with: 1) Greenhouse gas emissions 2) Air quality 3) Energy & feedstock management 4) Water management 5) Hazardous waste management 6) Safety & environmental stewardship of chemicals & GMO 7) Product design for use-phase efficiency 8) Political spending 9) Health, safety, and emergency management Details are provided in Table 73.

[250] http://www.sasb.org/sasb/standards-council/Actual members are high-level representatives of PwC, Ceres, e/co, Veris Wealth Partners, CDP, Georgia Institute of Technology – Ernest Scheller Jr. College of Business, McKinsey & Company, CalPERS, Perella Weinberg Partners LP, Paul, Weiss, Rifkind, Wharton & Garrison, LLP, SASB, KKR

[251] http://www.sasb.org/sasb/standards-council/Actual members are high-level representatives of UBS, Goldman Sachs – GS Sustain, Domini Social Investments LLC, Bloomberg Industries, SICM, BlackRock

[252] http://www.sasb.org/sasb/board-directors/

[253] http://www.sasb.org/sasb/donors/

[254] Supplement to Standards Outcome Review Report Resource Transformation. http://www.sasb.org/wp-content/uploads/2014/10/RT-Outcome-Report-Supplement-.pdf

[255] http://www.sasb.org/sasb/vision-mission/#1470330241691-4a8495cc-e204

[256] http://using.sasb.org/

Subject	Information
Concept of selected indicators	Strong focus on environmental, social and governance (ESG) issues / green chemistry
Launch year, change in concept (if any) since then	SASB is currently conducting an implementation review of the provisional standards, including stakeholder consultation regarding the content of the provisional standards. [257]
Proposed instruments and measures for implementation	For US and foreign public companies, annual filings (Form 10-K or 20-F) with the US Securities and Exchange Commission (SEC) are compulsory. "When making disclosure on sustainability topics, companies can use SASB Standards to help ensure that disclosure is standardized and therefore decision-useful, relevant, comparable, and complete." [260]
Status of implementation (e.g. description of best practice etc.)	There are 84 entries for SIC 2800 – Chemicals and Allied Products in the SEC database[258], but which of them have used SASB cannot be identified. No entry for "best practice" on SASB's website. As only 10 % of companies are integrating sustainability metrics into 10-K filings, using SASB standards can probably be regarded as best practice. This is supported by SASB's statement on SEC's current "Concept Release" (Business and Financial Disclosure Required by Regulation S-K; Concept Release, 81 Fed. Reg. 23916 (April 22, 2016).[259]
Status and type of monitoring including e.g. time series of indicator measurements	For US and foreign public companies, annual filing (Form 10-K or 20-F) with the US Securities and Exchange Commission (SEC) is compulsory, but using SASB Standards is not.
Stakeholder engagement	SASB is currently conducting an implementation review of the provisional standards, including stakeholder consultation regarding the content of the provisional standards. The focus of stakeholder consultation will ensure the SASB standards are: * A useful basis for investors' decision-making * Cost-effective and feasible for issuers to implement "At this juncture, SASB invites the public to direct questions to and/or schedule consultations with the sector analysts (see chart below)." [257] Resource Transformation: resource_transformation@sasb.org [257] In addition: http://www.sasb.org/category/blog/
Additional information	► Sustainability performance or Environment Social Governance (ESG) is of great importance for rating for sustainable investment, e.g. ► Dow Jones Sustainability Index (DJSI) (http://www.robecosam.com) ► FTSE4GOOD (http://www.ftse.com/products/indices/FTSE4Good) ► MSCI World ESG Index (https://www.msci.com/esg-integration)

Own compilation, using the following source: SASB website: http://www.sasb.org

[257] http://www.sasb.org/comment/

[258] https://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&SIC=2800&owner=include&match=&start=0&count=40&hidefilings=0

[259] SASB: Letter to Brent J. Fields, Secretary, United States Securities and Exchange Commission, July 1, 2016, page 8: „Consider the varied usefulness of these instances of water management disclosure made by two companies in the alcoholic beverages industry, one using boilerplate and one using metrics." https://www.sec.gov/comments/s7-06-16/s70616-25.pdf

9.1.2.3 Application in the chemical sector

SASB has introduced the Sustainable Industry Classification System™ which categorizes industry in ten sectors. Chemicals is part of the resource transformation sector (which also includes Aerospace & Defense, Electrical / Electronic Equipment, Industrial Machinery & Goods, Containers & Packaging), while pharmaceuticals are part of the health care sector.

"SASB Sustainability Accounting Standards are comprised of (1) disclosure guidance and (2) accounting standards on sustainability topics for use by U.S. and foreign public companies in their annual filings (Form 10-K or 20-F) with the U.S. Securities and Exchange Commission (SEC). … SASB Standards provide companies with standardized sustainability metrics designed to communicate performance on industry level sustainability topics. When making disclosure on sustainability topics, companies can use SASB Standards to help ensure that disclosure is standardized and therefore decision-useful, relevant, comparable, and complete."[260]

For the chemicals industry, SASB has identified nine sustainability disclosure topics. Table 73 shows the Sustainability Disclosure Topics & Accounting Metrics.[260]

Table 73: SASB: Sustainability Disclosure Topics & Accounting Metrics for the chemicals industry[260]

Topic	Accounting metric	Category	Unit of measure
Greenhouse Gas Emissions	Gross global Scope 1 emissions[246], percentage covered under a regulatory programme	Quantitative	Metric tons CO_2-e, Percentage (%)
	Description of long-term and short-term strategy or plan to manage Scope 1 emissions[246], emission-reduction targets and an analysis of performance against those targets	Discussion and analysis	n/a
Air quality	Air emissions for the following pollutants: NO_x (excluding N_2O), SO_x, volatile organic compounds (VOCs) and hazardous air pollutants (HAPs)	Quantitative	Metric tons (t)
	Number of production facilities in or near densely populated areas	Quantitative	Number
Energy & feedstock management	Total energy consumed, percentage grid electricity, percentage renewable[261]	Quantitative	Gigajoules (GJ), Percentage (%)
	Percentage of raw materials from renewable resources	Quantitative	Percentage (%) by metric tons
Water management	(1) Total water withdrawn, percentage in regions with high or extremely high baseline water stress and (2) percentage recycled water usage	Quantitative	Cubic metres (m^3), Percentage (%)
	Number of incidents of non-compliance with water quality permits, standards, and regulations	Quantitative	Number
Hazardous waste management	Amount of hazardous waste, percentage recycled	Quantitative	Metric tons (t), Percentage (%)

[260] SASB: CHEMICALS. Sustainability Accounting Standard. Sustainable Industry Classification System™ (SICS™) # RT0101. Prepared by the Sustainability Accounting Standards Board®, MARCH 2015, Provisional Standard.

[261] The registrant shall discuss its efforts to reduce energy consumption and/or improve energy efficiency throughout the production processes.

Topic	Accounting metric	Category	Unit of measure
Safety & environmental stewardship of chemicals & genetically modified organisms	Percentage of products that contain Registration, Evaluation, Authorisation and Restriction of Chemical (REACH) Substances of Very High Concern (SVHC)	Quantitative	Percentage (%) by revenue
	Percentage of products that contain Class I World Health Organization (WHO) Acute Toxicity Hazard Category pesticides	Quantitative	Percentage (%) by revenue
	Discussion of strategy to (a) manage chemicals of concern and (b) develop alternatives with reduced human and/or environmental impact	Discussion and analysis	n/a
	Percentage of products by revenue that contain genetically modified organisms (GMOs)	Quantitative	Percentage (%) by revenue
Product design for use-phase efficiency	Revenue from products designed for use-phase resource efficiency	Quantitative	U.S. Dollars ($)
Political spending	Amount of political campaign spending, lobbying expenditures, and contributions to tax-exempt groups, including trade associations	Quantitative	U.S. Dollars ($)
	Five largest political, lobbying, or tax-exempt group expenditures	Quantitative	U.S. Dollars ($), by recipient
Health, safety, and emergency management	Process Safety Incidents Count (PSIC), Process Safety Total Incident Rate (PSTIR), and Process Safety Incident Severity Rate (PSISR)[262]	Quantitative	Number, Rate
	Number of transport incidents[263]	Quantitative	Number
	Challenges to the Safety Systems indicator rate (Tier 3)	Quantitative	Rate
	Total recordable injury rate (TRIR) and (2) fatality rate for direct employees and (b) contract employees	Quantitative	Rate
	Discussion of efforts to assess, monitor and reduce exposure of employees and contract workers to long-term (chronic) health risks	Discussion and analysis	n/a

Own compilation, using the following source: SASB: CHEMICALS. Sustainability Accounting Standard. Sustainable Industry Classification System™ (SICS™) # RT0101. Prepared by the Sustainability Accounting Standards Board®, MARCH 2015, Provisional Standard

An example of one of the types of disclosure SASB envisions for its standards can be seen in a mock excerpt from a Form 10-K for a chemical company, "The Blair Chemical & Material Company," that

[262] The registrant shall describe incidents with a severity rating of 1 or 2, including their root cause, outcomes, and corrective actions implemented in response.

[263] The registrant shall describe significant transport incidents, including their root cause, outcomes, and corrective actions implemented in response.

incorporates disclosure to the SASB Standard for Chemicals into its Management's Discussion and Analysis of Financial Condition and Results of Operations (MD&A). [264] This excerpt emphasises again the purpose of the standards: To minimize risks for potential investors and the strong connection to green chemistry (page 8): "Since its inception, we have paid close attention to the green chemistry movement, and in 2004, we began implementing the 12 Principles of Green Chemistry as described by Anastas and Warner. All employees receive training in the 12 Principles, and their performance is, in part, assessed based on how well they follow them. Financial incentives are also provided to encourage employees to generate ideas that can improve our adherence to the principles."

9.1.2.4 Evaluation

SASB standards use the traditional definition of materiality and aim at a high level of comparability. However, they show some weaknesses, such as the very small number of issues identified per sector, little guidance on processes, standards or KPIs. [265] For example, the Sustainability Disclosure Topics & Accounting Metrics for the chemicals industry (see Table 73) focus on some main aspects, but might not identify all material issues for all companies (especially niche players). Further important aspects of sustainable development, such as product responsibility (incl. supply chain), resource conservation (biodiversity) or societal aspects (diversity and equality, indigenous people's rights etc.) are not covered.

Table 74: Evaluation of the SASB approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of sustainable chemistry. Sustainability is primarily regarded from the perspective of risk minimization for potential investors (material economic, environmental or social impacts).
Consistency of indicator concept and how it is monitored	Indicator concept is consistent with an investor's approach. Monitoring could be improved by making use of the SASB standards compulsory for SEC filings.
Role of SDGs in the concept	No direct link.
Probability of implementation	Increasing with investors' interest, but only in the US, as other countries do not have similar obligations
Overall impression	The focus lies clearly on risk minimization and ROCE (Return on Capital Employed). Important aspects of sustainable development, such as product responsibility (incl. supply chain), resource conservation (biodiversity) or societal aspects (diversity and equality, indigenous people's rights etc.) are not covered.

Source: Own compilation

9.1.2.5 Synergies and complementarities

The SASB approach can be easily integrated into other frameworks (including IIRC and GRI).

[264] http://www.sasb.org/wp-content/uploads/2013/09/RT0101_Chemicals-Mock-10-K_092915.pdf

[265] Dwayne Baraka: How do the major corporate sustainability reporting initiatives measure up? Posted on 20 of January, 2014. http://www.dwaynebaraka.com/blog/2014/01/20/major-corporate-sustainability-reporting-initiatives-gri-iirc-sasb-measure/

9.1.3 Interim conclusion on sustainability reporting

The main sustainability reporting approaches follow different viewpoints, as Elaine Cohen stated in March 2014:[266] "We are witnessing a leadership battle for ownership of sustainability transparency and it's not a good thing. … The battle is being played out on the respective turfs of the IIRC, SASB and the GRI, where IIRC and SASB are focused on what investors want to know in order to make more money and GRI is focused on what companies are doing to the world that makes it more or less sustainable."

To summarize, the short assessment of GRI and SASB shows that the GRI approach is more in line with the SDGs. With its G4 Guidelines, GRI has included supply chain and governance aspects as reporting indicators. However, GRI does not explicitly ask for the company's contribution to other global challenges with the exception of climate change. SASB's approach to chemicals is mainly focussed on green chemistry, supplemented with some societal aspects such as political spending, and neglecting others.

9.2 Approaches in sustainability rating and socially responsible investment

Environmental, social and corporate governance is an internationally established term in companies and the financial world. It describes whether and how business and industry have integrated ecological and social aspects and principles of corporate governance into their management and business practice. Many rating and research agencies or investors use the ESG approach, e.g. the UN Principles for Responsible Investment (UN PRI). However, ESG is not always equated with sustainable investment, because ESG often focuses on criteria central for corporate economic success, but not on more detailed aspects such as are found in other sustainability concepts, e.g. GRI.[267]

The leading indexes worldwide for investors interested in sustainable investment are Dow Jones Sustainability Index (DJSI), FTSE4GOOD and the MSCI World ESG Index. In addition, there are several regional (e.g. Hang Seng Corporate Sustainability Index[268]) or thematic indexes (e.g. Dax Global Alternative Energy Index[269]). In the following section, two of these indexes are described with reference to the chemicals industry.

9.2.1 Dow Jones Sustainability Index (DJSI) family

9.2.1.1 Background

"The Dow Jones Sustainability World Index was launched in 1999 as the first global sustainability benchmark. The DJSI family … tracks the stock performance of the world's leading companies in terms of economic, environmental and social criteria. The indices serve as benchmarks for investors who integrate sustainability considerations into their portfolios, and provide an effective engagement platform for companies who want to adopt sustainable best practices."

9.2.1.2 Characterization

Table 75: Dow Jones Sustainability Index (DJSI): Short Characterization

Subject	Information
Name/title	Dow Jones Sustainability Index (DJSI)
URL	http://www.robecosam.com

[266] Elaine Cohen, CEO of Beyond Business Ltd: GRI vs IIRC vs SASB: no synergy, no leadership. March 2014. http://www.ethicalperformance.com/analysis/article/8295

[267] https://www.nachhaltigkeit.info/artikel/esg_1609.htm

[268] http://www.hsi.com.hk/HSI-Net/HSI-Net

[269] http://www.dax-indices.com/EN/index.aspx?pageID=25&ISIN=DE000A1EXNT3

Subject	Information
Type of organisation	Investment Adviser
Coverage/region	Global
Institution(s) behind initiative/approach	The DJSI family is a joint offer of RobecoSAM and S&P Dow Jones Indices.
Legal information	"RobecoSAM AG is a subsidiary of Robeco Holding B.V. ("Robeco"), a Dutch investment management firm with headquarters in Rotterdam, Netherlands." http://www.sustainability-indices.com/important-legal-information.jsp "S&P Dow Jones Indices LLC is a joint venture of S&P Global, the controlling member, and CME Group Inc. S&P Global (NYSE: SPGI), and provides essential intelligence for individuals, companies and governments to support their decision-making. CME (NASDAQ: CME), the minority stakeholder, is a licensee of S&P DJI indices, as well as a data vendor." http://eu.spindices.com/our-company/our-history/
Governance bodies	Board of Directors. DJSI Index Committee: "The DJSI Index Committee consists of two RobecoSAM representatives and two S&P Dow Jones Indices representatives and meets on a quarterly basis. Severe incidents and breaches that cast strong doubts on a company's procedures and ability to handle the situation can be escalated to the DJSI Index Committee." http://www.sustainability-indices.com/sustainability-assessment/corporate-sustainability-assessment.jsp
President/CEO/ Chairman	Michael Baldinger, Chief Executive Officer, RobecoSAM
Year of foundation	1999
Budget/funding	Clients
Links/closeness to other stakeholders	RobecoSAM is a signatory of the UN PRI and a member of Eurosif, ASrIA and Ceres. RobecoSAM maintains research partnerships with academic institutions.
Target audience and sectoral/ geographical scope	"The indices serve as benchmarks for investors who believe sustainable business practices may lead to long-term shareholder value and who wish to reflect their sustainability convictions in their portfolios. Moreover, the DJSI serve as an effective engagement platform encouraging companies to adopt sustainable best practices."
Self-declared goal	"The concept of the DJSI was relatively straightforward: demonstrate that asset owners could invest in the world's most sustainable companies through a financial index that could be tracked in real-time, without detracting from investment returns."
Definition of sustainable chemistry OR sustainability	No explicit definition, but approach follows the triple bottom line principle: Companies are evaluated on the basis of a range of financially relevant sustainability criteria covering economic, environmental and social dimensions, based on e.g. GRI. "For each industry, the company with the highest score is named the RobecoSAM Industry Leader, and is considered to be the company within its industry that is best prepared to seize the opportunities and manage the risks deriving from economic, environmental and social developments."
Concept of selected indicators	Corporate Sustainability Assessment (CSA) "The CSA is a unique collection of questions and criteria addressing the most

Subject	Information
	material sustainability issues within each of the 59 industries that we assess. **The wide range of topics go beyond the traditional environmental, social, and governance approach, aiming to find the intersection between what matters most to companies and investors.** Topics like innovation management, customer relationship management, and tax strategy may not typically be associated with the term "sustainability," but for RobecoSAM, these are key areas that drive long-term value creation within companies." Most of the industry-specific questionnaires, such as the one for the chemicals industry, are not available to the public.
Launch year, change in concept (if any) since then	1999, continuously adapted (see timeline in Sustainability Yearbook 2016 http://yearbook.robecosam.com/timeline.html)
Proposed instruments and measures for implementation	The Best-in-Class Approach: "The Sustainability Yearbook also provides an overview of the results of our annual Corporate Sustainability Assessment and highlights key trends shaping each of the 59 analyzed industries."
Status of implementation (e.g. description of best practice etc.)	Implemented; best practice by Best-in-Class Approach
Status and type of monitoring including e.g. time series of indicator measurements	Annual report by yearbook.
Stakeholder engagement	Research collaboration with several academic institutes
Additional information	There are no negative criteria for exclusion. Weapons manufacturing, tobacco, alcohol, adult entertainment and gambling companies may be listed in the DJSI.

Own compilation, using the following source: RobecoSam website http://www.robecosam.com

9.2.1.3 Application in the chemical sector

The Best-in-Class Approach

The world's largest 2,500 publicly traded companies are invited to participate in RobecoSAM's CSA for possible inclusion in the DJSI World. Additional companies are invited to participate in the regional Dow Jones Sustainability Indices, totalling approximately 3,300 companies.[270] "Only the top ranked companies in terms of Corporate Sustainability within each industry are selected for inclusion in the Dow Jones Sustainability Index family. No industries are excluded from this process. … Thanks to the best-in-class approach, a vibrant competition among companies for inclusion in the Dow Jones Sustainability Indices has ensued. To be included or remain in the index, companies have to continually intensify their sustainability initiatives."[271]

[270] RobecoSAM's Corporate Sustainability Assessment Methodology 08/2016. http://www.robecosam.com/images/Measuring_Intangibles_CSA_methodology.pdf

[271] http://www.sustainability-indices.com/index-family-overview/djsi-family-overview/index.jsp

Corporate Sustainability Assessment (CSA)

"RobecoSAM developed the annual Corporate Sustainability Assessment (CSA) in 1999 in order to identify companies that are better equipped to recognize and respond to emerging sustainability opportunities and challenges presented by global and industry trends. … An interdisciplinary team of analysts designs, monitors and refines the CSA with the purpose of generating additional insights into the value-creating and risk-mitigating potential of companies, ensuring that the assessment focuses on sustainability criteria that are financially relevant to corporate performance, valuation and security selection. Not only does this make the results of the CSA assessment particularly relevant for investors, but it also helps companies to focus on sustainability issues that are more directly linked to their success as a business."[270]

CSA at a glance

- Since 1999, RobecoSAM has conducted the annual Corporate Sustainability Assessment (CSA), which serves as the framework for measuring corporate sustainability performance and forms the research backbone for the construction of the Dow Jones Sustainability Indices (DJSI) [1]
- The world's largest 2,500 publicly traded companies are invited to participate in RobecoSAM's CSA for possible inclusion in the Dow Jones Sustainability World Index (DJSI World)
- Additional companies are invited to participate in the growing family of regional and country-specific sustainability indices, such as the DJSI North America, Europe, Asia Pacific and Emerging Markets, totalling 3,400 invited companies
- 60 RobecoSAM industries derived from the GICS industry classification system are analyzed using industry-specific questionnaires [2]
- No industries are excluded from the assessment
- Companies are evaluated on the basis of a range of financially relevant sustainability criteria covering economic, environmental and social dimensions
- Companies receive a Total Sustainability Score between 0 – 100 and are ranked against other companies in their industry
- The top 10 % of companies within each industry are selected for inclusion in the DJSI World [3]
- The DJSI identify sustainability leaders across all industries, enabling investors to track their performance and integrate sustainability considerations into their portfolios

[1] Owned and managed by a jointventure between S&P Dow Jones Indices and MSCI.

[2] The Global Industry Classification System (GICS) is the most broadly used industry classification system for companies.

[3] The threshold for inclusion in the regional, local and DJSI Diversified Indices will vary.

'The starting point for the CSA is RobecoSAM's financial materiality framework. … For each of the 60 industries evaluated through the CSA, RobecoSAM's Sustainability Investing analysts (SI analysts) conduct a financial materiality analysis to identify those sustainability factors that drive business value and that have the greatest impact on the long-term valuation assumptions used in financial analysis. This analysis results in a materiality matrix for each industry, which serves as the basis for determining the applicability and weights of the various sustainability criteria in the CSA."[270]

"An integral component of the Corporate Sustainability Assessment is the Media & Stakeholder Analysis (MSA). The MSA process continuously monitors media coverage and other publicly available information from consumer organizations, governments or NGOs based on data provided by service provider RepRisk ESG Business Intelligence to identify companies' involvement and response to environmental, economic and social crisis situations that may have a damaging effect on their reputation and core business. …. The results of the MSA are built into the Corporate Sustainability Assessment and can reduce a company's Total Sustainability Score, thus affecting its inclusion in any of the DJSI Indices. In

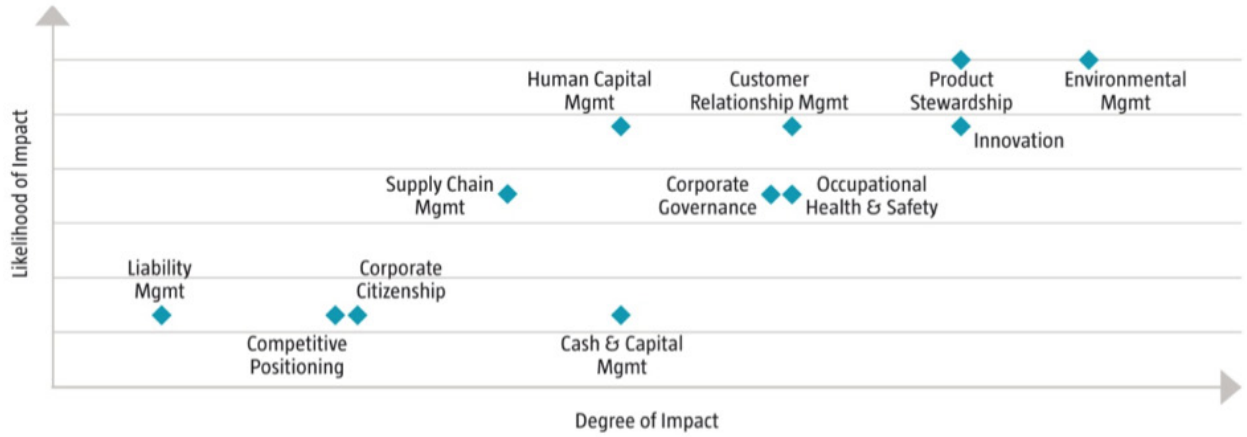
addition, severe incidents and breaches that cast strong doubts on a company's procedures and ability to handle the situation can be escalated to the DJSI Index Committee. Following a thorough analysis, the DJSI Index Committee may decide to change a company's eligibility immediately, regardless of the company's Total Sustainability Score."[272]

"Information provided in the questionnaire is verified for accuracy by crosschecking companies' answers with the supporting documentation they have provided, checking publicly available information, and by verifying a company's track record on crisis management with media and stakeholder reports."[272]

"Additional companies are assessed based exclusively on public information to ensure that 50 % of the market cap in the 59 industries in each region (or country for Australia and Korea) is covered."[273]

The chemicals industry

Figure 9: RobecoSam: Financial materiality matrix for the chemicals industry[274]



Source: DJSI: Detecting sector-specific, financial materiality. March 2016, User View by Rashila Kerai, Sustainability Analyst RobecoSAM, Switzerland. http://www.materialitytracker.net/2016/03/djsi-detecting-financial-materiality/

"The most significant issues and success factors in this *(= the chemical)* industry include Environmental Management, Product Stewardship, Innovation Management, Occupational Health and Safety, Customer Relationship Management, Corporate Governance, and Human Capital Management. Impacts on the business value drivers include:

- **Growth.** Innovation and product stewardship responding to changes in markets, customer demands, or competitive positioning.
- **Profitability.** Management of costs related to emissions, regulatory compliance, safety, or talent attraction and retention.
- **Risk.** Exposure due to corporate governance, business conduct, customer complaints, excessive safety incidences, or concerns from external stakeholders.

Therefore, these factors are also important for integrating sustainability into the investment case and identifying high quality companies that are attractive over the long term."[274]

[272] http://www.sustainability-indices.com/sustainability-assessment/corporate-sustainability-assessment.jsp

[273] RobecoSAM AG: CSA Guide – RobecoSAM's Corporate Sustainability Assessment Methodology, Version 3.0, 28 April 2016 http://www.sustainability-indices.com/images/corporate-sustainability-assessment-methodology-guidebook.pdf

[274] DJSI: Detecting sector-specific, financial materiality. March 2016, User View by Rashila Kerai, Sustainability Analyst RobecoSAM, Switzerland. http://www.materialitytracker.net/2016/03/djsi-detecting-financial-materiality/

"The materiality matrix also guides our annual revisions to the assessment for the Dow Jones Sustainability Index (DJSI) to capture relevant and emerging issues. The assessment consists of 59 questionnaires, one per industry, and covers a broad range of environmental, social, and governance topics. Some topics are general and apply to all industries, for example, corporate governance. However, more than half of the criteria are industry specific. For example, product stewardship is very relevant to chemical companies, but is less relevant to service companies."[274]

The questionnaire for the chemicals industry is not available. RobecoSAM DJSI Helpline wrote "Unfortunately, we only share the questionnaires with companies invited to participate in the Corporate Sustainability Assessment. Due to this company policy, we are unable to share the questionnaire with non-invited companies."[275]

The **driving forces for the chemical industry** are described as follows[276]: "Innovation and product stewardship remain key industry drivers. The main challenges facing the industry include operational eco-efficiency, climate change, human capital management, and occupational health & safety. Further, new product applications require the implementation of comprehensive product stewardship management systems that include product databases and client training. Increasingly, companies are adopting green chemistry practices, the use of (bio) catalysis and replacing traditional solvents and hazardous chemicals with renewable and/or bio-based materials. Offering products and solutions that provide sustainability benefits in the usage phase to help customers achieve their own sustainability targets is becoming a key differentiator for chemical companies."

9.2.1.4 Evaluation

The chemical industry is one of the 59 industries covered by the DJSI family. It belongs to the "Materials" sector which includes the following industries: Aluminium, chemicals, construction materials, containers & packaging, metals & mining, paper & forest products, and steel. Within the S&P 500 ESG Index, the share of "Materials" is 3.0 % and reaches only 5.6 % in the DJSI World Diversified (as of 31 March 2015). The materials sector is therefore only of minor relevance for DSJI.

DJSI is primarily a tool for larger, i.e. mainly institutional investors. That is why it features especially large, market-listed companies. The number of companies in the DJSI "universe" in 2015 was 2,126. Included are 125 chemical companies, 77 of them (= 62 %) were assessed by RobecoSAM. Their market capitalization – i.e. the aggregate valuation of these companies based on their current share price and the total number of outstanding stocks – in relation to total market capitalization was 84 %. Small and medium-sized enterprises are not a component of the DJSI family.

[275] RobecoSAM DJSI Helpline assessments@robecosam.com, email from Katie, 30.08.2016

[276] RobecoSAM: The Sustainability Yearbook 2016. http://yearbook.robecosam.com/ and http://yearbook.robecosam.com/pdf_downloads.html?file=files/rs_data/pdf/pdf_2016/RobecoSAM_Sustainability_Yearbook_2016.pdf

Table 76: DJSI: Corporate Sustainability Assessment (CSA) results 2015 for three industries (chemicals, pharmaceuticals, oil & gas)

	Chemicals	Pharmaceuticals	Oil & Gas
Highlighted criteria			
Economic dimension	► Customer relationship management ► Innovation management ► Supply chain management	► Innovation management ► Marketing practices ► Product quality and recall management	► Exploration & production ► Gas portfolio ► Risk & crisis management
Environmental dimension	► Climate strategy ► Operational eco-efficiency ► Product stewardship	► Climate strategy ► Environmental reporting ► Operational eco-efficiency	► Climate strategy ► Operational eco-efficiency ► Releases to the environment
Social dimension	► Human capital development ► Labour practice indicators and human rights ► Occupational health and safety	► Addressing cost burden ► Health outcome contribution ► Talent attraction & retention	► Labour practice indicators and human rights ► Occupational health and safety ► Social impacts on communities
Sustainability leaders 2016 (an explanation of classes is found at the end of the table):			
RobecoSAM Gold Class	► Akzo Nobel NV*, Netherlands ► Koninklijke DSM NV, Netherlands	► Roche Holding AG*, Switzerland	► Thai Oil PCL*, Thailand ► IRPC PCL, Thailand
RobecoSAM Silver Class	► BASF SE**, Germany ► Clariant AG, Switzerland ► Evonik Industries AG, Germany ► Novozymes A/S, Denmark ► Dow Chemical Co, United States ► PTT Global Chemical PCL, Thailand	► AbbVie Inc, United States ► AstraZeneca PLC, United Kingdom ► Sanofi, France	► -
RobecoSAM Bronze Class	► Linde AG, Germany ► Praxair Inc, United States	► Bayer AG, Germany ► GlaxoSmithKline PLC, United Kingdom ► Novo Nordisk A/S, Denmark	► Repsol SA, Spain

	Chemicals			Pharmaceuticals			Oil & Gas		
Sustainability Yearbook members	► Air Liquide SA, France ► Air Products & Chemicals Inc, United States ► Braskem SA, Brazil ► Ecolab Inc, United States ► LANXESS AG, Germany ► Mitsubishi Chemical Holdings Corp, Japan ► Sigma-Aldrich Corp, United States ► Solvay SA, Belgium			► Bristol-Myers Squibb Co, United States ► Daiichi Sankyo Co Ltd**, Japan ► Johnson & Johnson, United States ► Novartis AG, Switzerland ► Takeda Pharmaceutical Co Ltd, Japan			► BG Group PLC, United Kingdom ► Cenovus Energy Inc, Canada ► Ecopetrol SA, Colombia ► Eni SpA, Italy ► Galp Energia SGPS SA, Portugal ► MOL Hungarian Oil & Gas PLC, Hungary ► Neste Oyj, Finland ► Oil Search Ltd**, Australia ► PTT Exploration & Production PCL, Thailand ► PTT PCL, Thailand ► Royal Dutch Shell PLC, Netherlands ► Santos Ltd, Australia ► S-Oil Corp, South Korea ► TOTAL SA, France ► Woodside Petroleum Ltd, Australia		
Results at industry level	Av. score	Best score	Dimens. weight	Av. score	Best score	Dimens. weight	Av. score	Best score	Dimens. weight
Economic	60	94	36 %	53	88	45 %	53	89	37 %
Environment.	57	96	32 %	48	93	10 %	40	92	30 %
Social	58	94	32 %	43	90	45 %	48	94	33 %
Total score	58	92	-	48	88	-	47	90	-

* RobecoSAM Industry Leader: The company with the highest score
Gold Class 2016: Companies whose score is within 1 % of the Industry Leader's score
Silver Class 2016: All companies whose score is within a range of 1 % to 5 % of the Industry Leader's score
Bronze Class 2016: All companies whose score is within a range of 5 % to 10 % of the Industry Leader's score
** RobecoSAM Industry Mover: Within the top 15 % of each industry, the company that has achieved the largest proportional improvement in its sustainability performance compared to the previous year.
Own compilation, using the following source: RobecoSAM The Sustainability Yearbook 2016. http://yearbook.robecosam.com/ and http://yearbook.robecosam.com/pdf_downloads.html?file=files/rs_data/pdf/pdf_2016/RobecoSAM_Sustainability_Yearbook_2016.pdf and

The key point is transparency. The industry-specific criteria for 57 of the 59 industries are not published in detail. And how far are companies willing and able to provide the required information? According to the Sustainability Yearbook 2016, the average input required to complete a questionnaire was around 150 hours.

Table 77: Evaluation of the Dow Jones Sustainability Index (DJSI) approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of sustainable chemistry. At least 50 % of the questionnaire covers industry-specific risks and opportunities that focus on economic, environmental and social challenges and trends which are particularly relevant to companies within that industry.[270] The focus lies on reducing risks for investors.
Consistency of indicator concept and how it is monitored	The indicator concept for the chemicals industry is not available. The scoring process is unclear.
Role of SDGs in the concept	Referred to in the timeline as one of the "major global developments that have shaped the development of our methodology, reflecting the evolving global challenges that both companies and investors face." Referred to indirectly in the questionnaires[277] by reference to GRI-G4[278] and other international frameworks[279]
Probability of implementation	Not available for companies not invited to participate (not market-listed, especially SMEs).
Overall impression	As the indicator concept for the chemicals industry is not available (lack of transparency), applicability to sustainable chemistry cannot be verified. However, a listing in the DJSI is an incentive for innovative chemical companies (e.g. AkzoNobel/see sub-chapter 8.1.1.3, PTTGC/see sub-chapter 8.3.1). On the other hand, only large, listed companies are assessed. SMEs and start-ups, which are considered to be particularly innovative, fall through the grid. It therefore remains open, for example, whether the DJSI criteria are also applicable to these companies.

Source: Own compilation

9.2.1.5 Synergies and complementarities

"For Investors who wish to limit their exposure to controversial activities, RobecoSAM and S&P Dow Jones Indices offer the **DJSI World Diversified Select Index**. It follows the same index construction methodology as the DJSI World Diversified but excludes companies exposed to weapons manufacturing, tobacco, alcohol, adult entertainment and gambling."[280]

[277] Available: http://www.robecosam.com/images/sample-questionnaire-metals-and-mining.pdf and http://www.robecosam.com/images/sample-questionnaire-diversified-consumer-services.pdf

[278] see the GRI Mapping – Index in: RobecoSAM's Corporate Sustainability Assessment Companion, April 2016 https://assessments.robecosam.com/documents/RobecoSAM_CSA_Companion_2016.pdf

[279] e.g. OECD Convention on Combating Bribery of Foreign Public Officials in International Business Transactions, 1997; United Nations Convention Against Corruption, 2003; Business Principles for Countering Bribery, 2009 (by Transparency International, second edition

[280] http://www.sustainability-indices.com/index-family-overview/djsi-diversified-family-overview/index.jsp

9.2.2 The MSCI ACWI Sustainable Impact Index

9.2.2.1 Background

"MSCI ACWI captures large and mid cap representation across 23 Developed Markets (DM) and 23 Emerging Markets (EM) countries[281]. With 2,481 constituents, the index covers approximately 85 % of the global investable equity opportunity set."[282]

The MSCI ACWI Sustainable Impact Index was launched in the spring of 2016 under ithe parent index MSCI ACWI. "This framework was developed following a client consultation with more than 25 of the world's leading asset owners and managers, who agreed that there is room for new impact-oriented thematic investment approaches in public equity markets. To date, impact investing has largely been limited to small-scale, private equity strategies but there has not been a tool aiming to measure the extent to which exchange listed companies are involved in solutions for a more sustainable society and environment. The SDGs gave us the opportunity to offer tools to provide insight into what we define as Sustainable Impact."[283]

Impact investing

"Impact investing is an approach that intentionally seeks to create positive social and environmental impacts alongside financial returns. Investors generally define the positive impacts they are targeting during investment due diligence and seek to measure the generation of those impacts throughout the lifecycle of the investment."

Source: J.P. Morgan Private Bank: Decoding the Elements of Sustainable Investing. https://am.jpmorgan.com/blob-pbstudio/1383335319956/83456/sustainable-investing-2016.pdf

"It is not possible to invest directly in an index. Exposure to an asset class or trading strategy or other category represented by an index is only available through third party investable instruments (if any) based on that index."[284]

9.2.2.2 Characterization

"MSCI ESG indexes are designed to represent the most prevalent environmental, social and governance (ESG) investment strategies, utilizing our award-winning ESG data and ratings on thousands of companies worldwide. Institutional investors interested in sustainable investing can use these industry-leading indexes to benchmark ESG investment performance, issue index-based ESG investment products, and manage and report on ESG mandate compliance."[285]

MSCI ESG indexes consist of eight index families, three of which referm to values (e.g. ex fossil fuels), three to integration (e.g. global sustainability), and two to impact (sustainable impact). The ESC methodology is basically the same for all of them. "MSCI ESG Ratings identify six to ten key ESG issues where companies in that industry currently generate large environmental or social externalities; these

[281] DM countries include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the UK and the US.
EM countries include: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Russia, Qatar, South Africa, Taiwan, Thailand, Turkey and United Arab Emirates.

[282] MSCI ACWI (USD), JUN 30, 2016 https://www.msci.com/resources/factsheets/index_fact_sheet/msci-acwi.pdf

[283] MSCI: MSCI ESG Research Develops Framework to Support Alignment with the UN Sustainable Development Goals. New Index and Metrics designed to support sustainable impact among institutional investors. Press release, April 12, 2016 https://www.msci.com/documents/10199/4c399d51-b29e-45a2-bf7f-c64a8d391aea

[284] MSCI ACWI Sustainable Impact Index methodology. May 2016 https://www.msci.com/eqb/methodology/meth_docs/MSCI_Sustainable_Impact_Index_May2016.pdf

[285] https://www.msci.com/esg-indexes

are issues where some companies may be forced to internalize unanticipated costs associated with those externalities in the future. Corporate Governance is assessed for all companies."[286]

Table 78: MSCI ESG Key Issue Hierarchy[286]: Short Characterization

3 Pillars	10 Themes	37 ESG Key Issues	
Environment	Climate change	Carbon emissions* Energy efficiency Product carbon footprint	Financing environmental impact climate change vulnerability
	Natural resources	Water stress* Biodiversity & land use	Raw material sourcing
	Pollution & waste	Toxic emissions & waste* Packaging material & waste	Electronic waste
	Environmental opportunities	Opportunities in clean tech Opportunities in green building	Opportunities in renewable energy
Social	Human capital	Labour management*, Health & safety*	Human capital development, supply chain labour standards
	Product liability	Product safety & quality, chemical safety, financial product safety	Privacy & data security, responsible investment, health & demographic risk
	Stakeholder opposition	Controversial sourcing	
	Social opportunities	Access to communications Access to finance	Access to health care; nutrition & health
Governance	Corporate governance*	Board** Pay**	Ownership** Accounting**
	Corporate behaviour	Business ethics* Anti-competitive practices*	Corruption & instability; financial system instability

* Indicates "universal" issues assessed for all companies in MSCI World
** Board, Pay, Ownership, and Accounting carry weight in the ESG Rating model for all companies. Currently, they contribute to the Corporate Governance score directly and 0-10 sub-scores are not available.
Own compilation, using the following sources: MSCI: ESG RATINGS METHODOLOGY. Executive Summary. MSCI ESG Research, May 2015 https://www.msci.com/documents/10199/123a2b2b-1395-4aa2-a121-ea14de6d708a

While the MSCI Global Sustainability Indexes ("target the highest ESG-rated companies making up 50 % of the adjusted market capitalization in each sector of the underlying index") are comparable to the DJSI, the impact indexes have another approach. They refer to the risks and opportunities of the world's environmental (climate change) or social and environmental challenges.

The MSCI ACWI Sustainable Impact Index is "designed to identify listed companies whose core business addresses at least one of the world's social and environmental challenges, as defined by the United Nations Sustainable Development Goals (UN SDGs). … To be eligible for inclusion in the Index, companies must generate at least 50 % of their sales from one or more of the eleven Sustainable Impact categories. … Companies must maintain minimum environmental, social and governance (ESG) standards to be eligible for inclusion." [284]

Minimum ESG standards include, for example, limits for sales from tobacco or alcohol production (maximum 10 % each), no involvement in predatory lending practices or in manufacture of controversial (e.g. cluster munitions, landmines, depleted uranium, biological & chemical weapons) or nuclear

[286] MSCI: ESG RATINGS METHODOLOGY. Executive Summary. MSCI ESG Research, May 2015 https://www.msci.com/documents/10199/123a2b2b-1395-4aa2-a121-ea14de6d708a

weapons, limits for revenues from conventional weapons and civilian firearms (maximum 5 % each). [284] Table 79 shows the MSCI Sustainable Impact categories and the corresponding SDGs.

Table 79: MSCI Sustainable Impact categories and corresponding SDGs

Pillar	Themes	Impact categories[284]	Corresponding UN SDG
Environmental	Climate change	1. Alternative energy	7 Affordable and clean energy
		2. Energy efficiency	7 Affordable and clean energy
		3. Green building	11 Sustainable cities and communities 13 Climate action
	Natural capital	4. Sustainable water	6 Clean water and sanitation 11 Sustainable cities and communities
		5. Pollution prevention	12 Responsible consumption and production
Social	Basic needs	6. Nutrition	2 Zero hunger
		7. Major disease treatment	3 Good health and well-being
		8. Sanitation	6 Clean water and sanitation 11 Sustainable cities and communities
		9. Affordable real estate	1 No poverty 11 Sustainable cities and communities
	Empowerment	10. SME finance	9 Industry, innovation and infrastructure
		11. Education	4 Quality education

Own compilation, using the following sources: MSCI ACWI Sustainable Impact Index methodology. May 2016 https://www.msci.com/eqb/methodology/meth_docs/MSCI_Sustainable_Impact_Index_May2016.pdf and https://sustainabledevelopment.un.org/sdgs

"Securities are weighted on the basis of sustainable impact dollar sales in proportion of the ratio of free-float adjusted market capitalization of security to total market capitalization of issuer. Sustainable impact dollar sales are computed using product of the trailing 12-month sales and the cumulative percentage of sales from the sustainable impact categories. Additionally, sector weights are capped at 20 % and issuer weights are capped at 4 %. The Index is rebalanced quarterly coinciding with the Quarterly Index Reviews of the parent ACWI Index. …

$$Security\ Weight = \left(Sustainable\ impact\ sales\ \% \times Trailing\ 12-month\ sales \times \frac{Free-float\ adjusted\ market\ capitalization\ of\ security}{Total\ market\ capitalization\ of\ issuer}\right)$$

… The above weights are then normalized to 100 %.

Additionally, sector weights are capped at 20 % and issuer weights are capped at 4 %.

… The MSCI ACWI Sustainability Impact Index is reviewed on a quarterly basis to coincide with the Quarterly Index Reviews of the Parent Index."[284]

Table 80: MSCI ACWI Sustainability Impact Index

Subject	Information
Name/title	MSCI ACWI Sustainability Impact Index
URL	https://www.msci.com/
Type of organisation	Investment Adviser
Coverage/region	Global
Institution(s) behind initiative/approach	Created by Morgan Stanley (a financial service) in 1986 as the Morgan Stanley Capital International (MSCI) indexes.
Legal information	MSCI Inc. became a fully independent, stand-alone public company in 2009.
Governance bodies	Board of Directors. Three committees (Audit, Nominating and Governance, Compensation) with independent directors
President/CEO/Chairman	Henry Fernandez, Chairman and CEO since 1998
Year of foundation	1986 (Indexes) / 2009 (Inc.)
Budget/funding	Clients
Links/closeness to other stakeholders	No information.
Target audience and sectoral/geographical scope	Institutional investors who are integrating environmental, social and governance (ESG) factors into their investment decision making processes.
Self-declared goal	Leading provider of investment tools.
Definition of sustainable chemistry OR sustainability	No explicit definition, but ESG principle: Companies are evaluated on the basis of a range of financially relevant sustainability criteria covering environmental, social and governance aspects. "The MSCI ACWI Sustainable Impact Index is "designed to identify listed companies whose core business addresses at least one of the world's social and environmental challenges, as defined by the United Nations Sustainable Development Goals (UN SDGs)."
Concept of selected indicators	"To be eligible for inclusion in the Index, companies must generate at least 50 % of their sales from one or more of the eleven Sustainable Impact categories." The sustainable impact categories correspond to different SDGs, see Table 79. ESG is the minimum for the MSCI ACWI Sustainable Impact Index; there is a negative list of prohibited or restricted activities (e.g. weapons).
Launch year, change in concept (if any) since then	ESG rating: 2010[287] MSCI ACWI Sustainable Impact Index: Started in 2016
Proposed instruments and measures for implementation	Rating corresponding to the sales of products and services corresponding to the defined impact categories which correspond to several SDGs

[287] MSCI: MSCI ESG RATINGS. Factsheet. https://www.msci.com/documents/1296102/1636401/MSCI_ESG_Ratings.pdf/9f0a999b-4419-4a0a-b6ef-0248f40ca2c9

Subject	Information
Status of implementation (e.g. description of best practice etc.)	Implemented; best practice by Best-in-Class Approach
Status and type of monitoring including e.g. time series of indicator measurements	Quarterly update.
Stakeholder engagement	No information.
Additional information	The names of the companies included, but not listed in the TOP ranges, are not published.

Own compilation, using the following source: MSCI website https://www.msci.com

9.2.2.3 Application in the chemical sector

"As of 31 March 2016, the MSCI ACWI Sustainable Impact Index has 88 constituents and contains significant exposure to the United States (40.6 %), France (12.2 %), Japan (7.6 %), Denmark (6.4 %) and the United Kingdom (5.8 %). The major sub-industry exposures are to biotechnology (14.3 %), electrical components and equipment (10.0 %), household products (9.2 %), packaged foods and meat (8.2 %) and auto parts and equipment (8.0 %). The top five companies are Valeo – Pollution Prevention (4.5 %), Schneider Electric – Energy Efficiency (4.1 %), Pearson – Education (4.1 %), ABB – Energy Efficiency (4.1 %), and Vestas – Alternative Energy (3.9 %)."[288]

"Based on MSCI ESG Sustainable Impact Metrics, using index constituents and weights as of March 2016, the MSCI ACWI Sustainable Impact Index had 71 % greater exposure to estimated company revenue derived from sustainable impact solutions compared to the parent, MSCI ACWI Index."[289]

Table 81: TOP 10 constituents of the MSCI ACWI Sustainable Impact Index (dated 29 July 2016)

Constituents	Country	Index Wt. (%)	Parent Index Wt. (%)	Sector	Sector Wt. (%)
ABBVIE	US	4.14	0.29	Health care	20.7
UMICORE	BE	4.04	0.01	Materials	94.6
PROCTER & GAMBLE CO	US	4.03	0.62	Consumer staples	19.9
SCHNEIDER ELECTRIC	FR	3.99	0.10	Industrials	20.6
LENDLEASE GROUP	AU	3.95	0.02	Financials	53.3
VESTAS WIND SYSTEMS	DK	3.94	0.04	Industrials	20.4
SUEZ	FR	3.92	0.01	Utilities	43.4
PEARSON	GB	3.68	0.03	Consumer discretionary	55.5
ABB LTD	CH	3.54	0.11	Industrials	18.3
GILEAD SCIENCES	US	3.48	0.29	Health care	17.4
Total		**38.71**	**1.52**		

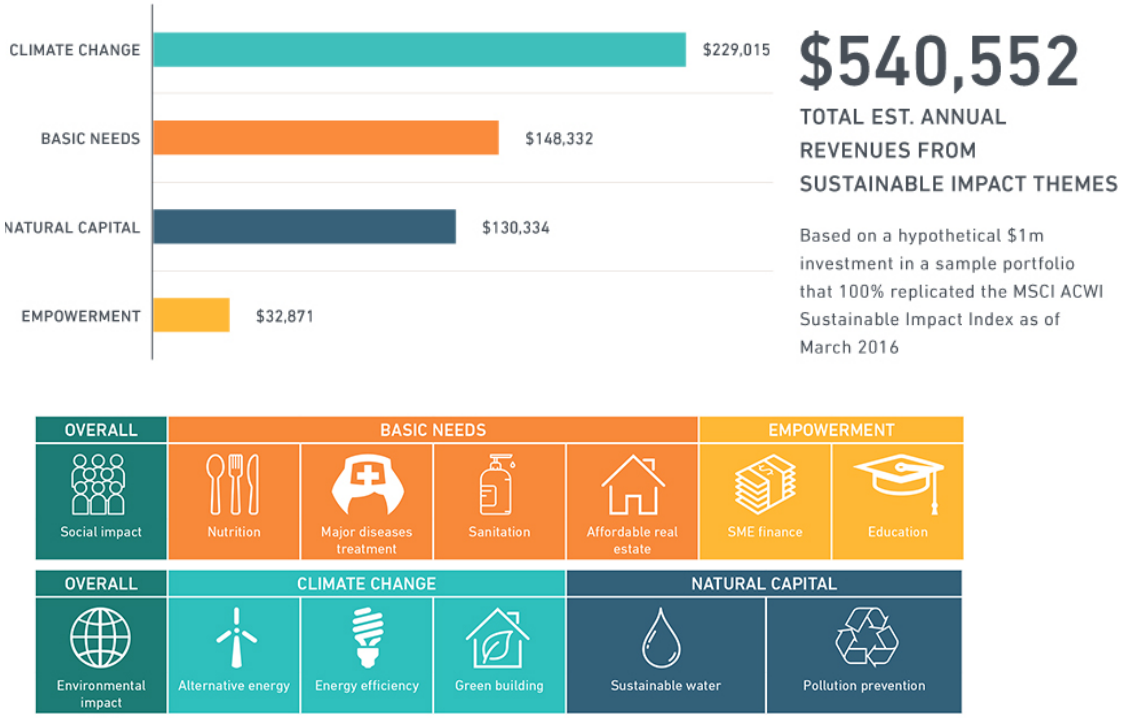
Own compilation, using the following sources: MSCI ACWI SUSTAINABLE IMPACT INDEX (USD). 29 July 2016 https://www.msci.com/documents/10199/6d2b3e68-90e0-448e-bd52-eaf0397539d1

[288] James Lord: MSCI launches new ESG metrics for sustainable ETFs. Apr 14th, 2016 http://www.etfstrategy.co.uk/msci-launches-new-esg-metrics-for-sustainable-etfs-15124/

[289] https://www.msci.com/msci-acwi-sustainable-impact-index

A complete list of all the 88 constituents is not available at the MSCI website. The TOP 10 constituents as of the end of July 2016 are shown in Table 81. Four of the TOP 5 companies from March 2016 are still in the TOP 10. No chemical company is listed in the TOP 10 as of July 2016.

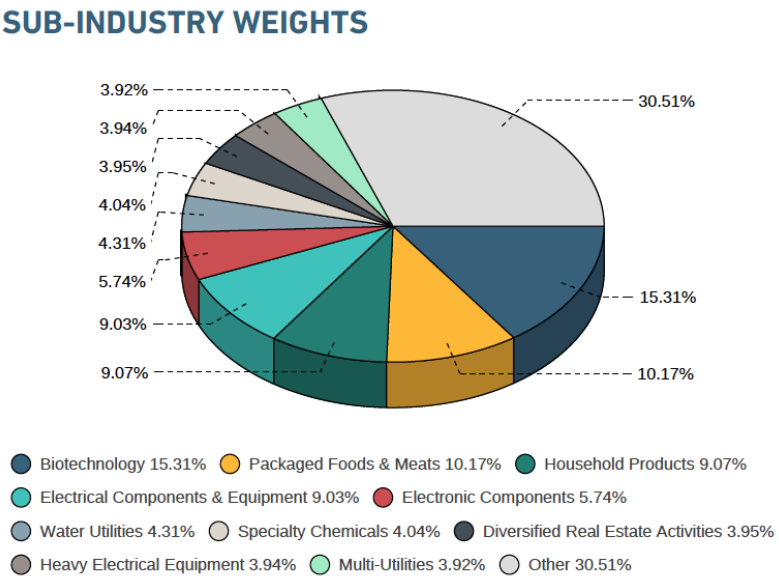
Figure 10: Estimated constituent annual revenues derived from sustainable impact themes[289]



Source: MSCI: MSCI ACWI Sustainable Impact Index https://www.msci.com/msci-acwi-sustainable-impact-index

Chemicals play a minor role in the MSCI ACWI Sustainable Impact Index. In August 2016, specialty chemicals contributed only about 4 % to the index (Figure 11).

Figure 11: MSCI ACWI Sustainable Impact Index: Sub-industry weights (August 2016)



Source: MSCI: MSCI ACWI Sustainable Impact Index (USD) https://www.msci.com/documents/10199/6d2b3e68-90e0-448e-bd52-eaf0397539d1

9.2.2.4 Evaluation

The MSCI ACWI Sustainable Impact Index introduces a new approach, which focuses on the SDGs and is in line with GRI G4, asking for the impact of the companies' business, while Environmental, Social and Governance standards are a prerequisite. The chemical industry does not seem to make a large contribution to this index. This is probably due to the fact that most of the sales of large chemical companies cannot be allocated to the impact categories or are excluded because of the selection criteria. For example, corporate operational energy efficiency efforts, such as efficiency gains in manufacturing, transporting, or distributing standard products or services, are excluded. In addition, voluntary projects which respond to the SDGs – some examples are described by CEFIC[290], e.g. the Novartis Malaria Initiative – are neglected as they do not contribute to the company's sales.

However, the 50 % minimum requirement is the biggest challenge: "To be eligible for inclusion in the Index, companies must generate **at least 50 % of their sales** from one or more of the eleven Sustainable Impact categories." Most chemical industry sales are not directly linked to the SDGs or the MSCI Sustainable Impact Categories.

This can be illustrated by Akzo Nobel, a global paints, coatings and specialty chemicals company and DJSI's chemicals industry leader 2016 (see Table 76). Its business areas are coatings, decorative paints and specialty chemicals, which is related to the Pollution Prevention category: "This category includes products, services, or projects that support pollution prevention, waste minimization, or recycling as a means of alleviating the burden of unsustainable waste generation, including: …

- Sustainable alternative materials including raw materials, paints, adhesives, etc. used primarily in the construction of environmentally sustainable buildings."

This requirement means that Akzo Nobel first has to generate at least 50 % of its sales from sustainable alternative materials and second has to prove that these materials are used primarily in the construction of environmentally sustainable buildings. For the first requirement, Akzo Nobel's target is to reach 20 % of revenue by 2020 from products that are more sustainable for its customers than the products of its competitors.[291] This is far removed from the requirement of the MSCI ACWI Sustainable Impact Index (50 %). In addition, Akzo Nobel can scarcely fulfil the second requirement, as the traceability of its products' use is very limited and AkzoNobel as a rule has no influence on the kind of building for which its products are used.

Table 82: Evaluation of the MSCI ACWI Sustainable Impact Index approach

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No explicit definition of sustainable chemistry. Sustainability is measured by the sales of products and services that are attributed to impacts corresponding to SDGs. Application in the chemicals industry is currently unclear.
Consistency of indicator concept and how it is monitored	The indicator concept for the chemicals industry is not available. The scoring process is unclear.
Role of SDGs in the concept	SDGs determine the impact categories; strong influence.
Probability of implementation	Currently not available for companies which are not market-listed, especially SMEs.

[290] http://www.cefic.org/sustainability/UN-Sustainable-Goals/

[291] Ton Büchner and Andre Veneman, AkzoNobel: 2016 Sustainability Update, May 19, 2016 https://a96fa647e5e0932a529c-f3023a2080eb9170df7c92d8b2a39df1.ssl.cf3.rackcdn.com/sustainability_update_presentation.pdf

Subject	Comment
Overall impression	An interesting because developable approach for sustainable chemistry, as it focuses on industry's impact by the sales of their products and services. On the other hand, only large, listed companies are assessed. SMEs and start-ups, which are considered to be particularly innovative, fall through the grid. It therefore remains open, for example, whether the MSCI criteria are also applicable to these companies.

Source: Own compilation

9.2.2.5 Synergies and complementarities

Different ESG indexes exist for various investment criteria. The *MSCI Global Sustainability Indexes* (MSCI ACWI ESG Index, MSCI World ESG Index and MSCI EM ESG Index) target the highest ESG-rated companies, which make up 50 % of the adjusted market capitalization in each sector of the underlying index. The *MSCI Global SRI Indexes* consist of companies with the highest ESG ratings, which make up 25 % of the adjusted market capitalization in each sector of a parent MSCI index, after excluding companies involved in alcohol, tobacco, gambling, civilian firearms, military weapons, nuclear power, adult entertainment and genetically modified organisms (GMOs). *MSCI Global Environmental Indexes* provide low carbon, fossil fuels exclusion and thematic indexes for investors.[292]

9.2.3 Interim conclusion on sustainability rating and socially responsible investment

In this study, two concepts are described: The Dow Jones Sustainability Index (DJSI) and the MSCI ACWI Sustainable Impact Index. Positioning in the DJSI is an incentive for innovative chemical companies (e.g. AkzoNobel/see sub-chapter 8.1.1.3, PTTGC/see sub-chapter 8.3.1.2). However, the MSCI ACWI Sustainable Impact Index probably has more potential for application in the area of sustainable chemistry as it – consideration of ESG criteria and excellent operational performance provided – on the impact of chemical companies with regard to the SDGs. In both cases, only large, listed companies are assessed. SMEs and start-ups, which are considered to be particularly innovative, are falling through the grid. It therefore remains open, for example, whether the DJSI MSCI ACWI criteria are also applicable to these companies. Since neither the indicator concept for the chemicals industry nor the scoring process is available in detail, no further evaluation is possible.

10 Approaches from further non-governmental/non-profit organizations

10.1 MVO Nederland, Netherlands

10.1.1 Characterization

"MVO Nederlands (CSR Netherlands) was founded in 2004 by the Dutch Ministry of Economic Affairs. Four years earlier, in 2000, the Dutch Social and Economic Council (SER) had issued a report entitled Value from Values, in which it recommended the establishment of an organization to promote an agenda of corporate social responsibility. It was the SER's view that business should not be conducted at the expense of people and the environment. The SER also noted that entrepreneurs are corporate citizens who should devote a share of their profits to giving something back to society. Ultimately, the recommendations in this report led to the creation of CSR Netherlands." [293] "CSR Netherlands is now the largest CSR-network in Europe, probably worldwide. It is a foundation that 50% privately funded (by her 2,300 partners (companies and sector assocations)) and 50% publicly funded (Ministry of

[292] https://www.msci.com/esg-indexes

[293] http://mvonederland.nl/dossier/history

Economic Affairs, Ministry of Infrastructure and Environment, Ministry of Foreign Affairs, and EU funding)." [294]

"Working together, the associations, companies, NGOs, research institutions, and educational, healthcare and other public authorities in our network translate CSR directly into market opportunities at three levels: the sector, the region and the chain. CSR Netherlands already reaches more than 100,000 entrepreneurs in a wide spectrum of industries, including healthcare, building and construction, textile, agriculture, facility management and clean tech." [295]

Further details are provided in Table 83. Information was mainly sourced from MVO's website[296] and personal communication from MVO[297].

Table 83: MVO Nederland, Netherlands: Short Characterization

Subject	Information
Name/title	MVO Nederland (CSR Netherlands)
URL	http://mvonederland.nl
Type of organisation	Non-profit organization, multi-stakeholder organization, independent foundation
Coverage/region	Netherlands and international
Institution(s) behind initiative/approach	See Budget/funding
Legal information	Independent foundation (ANBI = algemeen nut beogende instellingen)
Governance bodies	Supervisory board (Raad van Toezicht) Programme council (Programmaraad)
President/CEO/Chairman	Chair: Peter Blom, CEO of the Triodos Bank, also chair of the supervisory board and the programme council Maria van der Heijden, Director
Year of foundation	2004
Budget/funding	► 50% privately funded by 2,300 partners of the CSR network (companies and sector assocations) ► 50% publicly funded (Ministry of Economic Affairs, Ministry of Infrastructure and Environment, Ministry of Foreign Affairs, assignments from of Dutch Provinces and Dutch municipalities, and EU funding)
Links/closeness to other stakeholders	MVO is a member of CSR Europe, the fast-growing European overarching organization of national CSR organizations, which together represent more than 10,000 companies. CSR Netherlands represents about 20% of them and thus constitutes Europe's largest CSR network.
Target audience and sectoral/geographical scope	MVO is the Centre of Excellence for Dutch companies that are striving towards corporate social responsibility. More than 2,300 companies are affiliated with this networking organization.
Self-declared goal	MVO helps companies to become futureproof, that is to adopt measures and practices. Besides that MVO supports companies to be transparant and have stakeholder dialogues as input for the company strategy.

[294] E. Roelofs, MVO Nederlands, pers. comm.

[295] http://mvonederland.nl/dossier/business-network

[296] http://mvonederland.nl

[297] E. Roelofs, MVO Nederlands, 2.2.2017

Subject	Information
Definition of sustainable chemistry OR sustainability	"Corporate social responsibility (CSR) is an integral vision of sustainable business practices. CSR Netherlands' approach to CSR is based on the European Commission's definition: corporate social responsibility refers to companies taking responsibility for their impact on society." "They consider the social, environmental and economic (people, planet and profit) impact of all their decisions, while taking into account the interests of stakeholders."298
Concept of selected indicators	"CSR: ► Creates value socially, ecologically and economically. This is referred to as the 3 Ps: People, Planet and Profit. ► Plays a role in all company processes, from purchasing to marketing and from production to HRM (Human Resource Management). Social issues emerge in every aspect of enterprise. ► Requires companies to weigh the interests of their different stakeholders, including the people involved and other companies and organizations. ► Is different for every company. The measures implemented will depend on the company's size, sector, corporate culture and business strategy. ► Is a process, not a final destination. Goals may change with time and the decisions a company takes along the way."
Launch year, change in concept (if any) since then	n.a.
Proposed instruments and measures for implementation	Introduction of corporate social responsibility (CSR) in general, e.g. integrating CSR into corporate structures in accordance with ISO 26000 standards; for the chemical industry see next paragraph
Status of implementation (e.g. description of best practice etc.)	CSR Netherlands has 16 networks in which companies are actively setting up joint activities to stimulate sustainable development in the sector. Six of these networks were set up to develop projects that make international value chains of these sectors with developing countries more sustainable (ICSR program). These sector networks are focussed on the chemical, maritime, textile, leather, agrofood sector and the urban development. Besides these is a sector network on the care and cure sector, tourism and concrete. Declared best practice in chemical industry in terms of supply chain management: AkzoNobel [299]
Status and type of monitoring including e.g. time series of indicator measurements	n.a.
Stakeholder engagement	Stakeholder engagement and multistakeholder dialogue are essential parts of CSR.
Additional information	A number of (partly custom-made) tools have been developed to assist the business community with CSR, Some of the tools are available in English (http://mvonederland.nl/dossier/csr-tools):

298 MVO Nederlands (CSR Netherlands): INTERNATIONAL CSR IN THE DUTCH CHEMICAL SECTOR. November 2015. http://mvonederland.nl/sites/default/files/media/CSRNL_Quickscan%20International%20CSR%20in%20the%20Dutch%20Chemical%20Sector.pdf

Subject	Information
	► CSR Risk Check helps companies assess the international CSR risks associated with doing business abroad. ► CSR MAPS, which partners can use to determine their level of CSR adaptation. ► CSR STEPS enables businesses to develop their own CSR policy. ► CSR Guide ISO 26000 enables structural CSR adaptation based on ISO 26000.

Own compilation, using the following source: MVO Nedersland's website http://mvonederland.nl

10.1.2 Application in the chemical sector

The sector programme 'International CSR in the Dutch Chemical Sector' is part of an international CSR (ICSR) umbrella programme financed by the Netherlands Ministry of Foreign Affairs. CRS Netherlands' role in this programme is to work with a group of SMEs and important stakeholders from six industries including the chemical sector to find or develop social and technical innovations, new sustainable production methods and to ensure optimum collaboration with chain partners. The experience gained during this programme will serve as an example and an inspiration to the industry as a whole and, subsequently, other industries." [299]

Based on a scoping study Quickscan for International CSR in the Dutch Chemical Sector, CSR Netherlands pointed out eight starting points for (system) innovation which offer companies in the chemical sector opportunities to tackle CSR issues and for further sustainable development in the sector:[298]

- Circular economy
- Biobased economy and chemistry
- Small-scale chemistry
- Smart, functional materials
- CO_2 economy
- Sustainable products for developing countries
- Valorization of side streams and invasive species
- Modernization of existing industries in developing countries

MVO points out the need for supportive legislative frameworks for this new business approach, especially more flexible regulations for early innovators and frontrunners, simplification of legislation including REACH (e.g. registration of groups of substances instead of single substances) and supporting or strengthening initiatives that support the ICSR agenda, such as Together for Sustainability (see 6.3) or the Responsible Care Programme.

"For the **international CSR sector trajectory** we have identified the following challenges and opportunities specifying how we, as a Dutch sector, can contribute to sustainable chemistry. These are:

[299] http://mvonederland.nl/nieuws/transparency-value-chain-essential-sustainable-chemistry

- Transparency in the value chain on CSR risks;
- Sustainable production throughout the value chain;
- Sustainable sourcing;
- Development of sustainable products aimed at developing countries;
- A trust-based relationship between chemical companies and the government/society;
- Circular products and services;
- Diversity in scale."

Since end of 2015 CSR Netherlands, together with a group of ten chemical companies and two NGO's, is developing joint projects based on four of these eight challenges: transparency in the value chain on CSR risks; sustainable sourcing and production throughout the value chain; trust based relationship between chemical companies and the government; circular products and services.

Within the 2016 report on its IMVO-programme 'Samen veranderen' [MVO Nederland, 2017], MVO has published a set of goals and indicators for measuring progress in its international CSR sector trajectory on chemistry ("IMVO-Sectortransitietraject Chemie"). Table 84 shows

Table 84: Goals and indicators for measuring progress in the international CSR (ISCR) sector trajectory on chemistry ("IMVO-Sectortransitietraject Chemie"), MVO Nederland, Netherlands

Code	Intended results: Sector Transition Pathway Chemistry	Measuring method/indicator
AA1	Sector Analysis has been prepared	Check: yes/no
AA2	20 interviews made with companies and other stakeholders	Number of interviews made
A1	Sector coalition (change network) has at minimum 30 paricipants	Number of participants in the sector coalition
A2	Nine meetings with coalition members have been performed	Number of meetings with coalition members
B1	Jointly developed perspective (vision and ambition)	Check if vision / ambition is available
C1	Jointly developed action plan	Check if action plan is available
D1	At least 4 change projects have been approved and launched	Number of change projects
D2	At least 20 members of the sector coalition (see A1) participate in one or more change projects	Number of participants in change projects
D3	Minimum total amount of co-financing = 36,300 € per sector (over 3 years)	Total amount AND percentage of co-financing
D4	Change projects are monitored and evaluated on international corporate social responsibility (ICSR) impact	Number of change projects that have been evaluated on indicators
D5	Change Projects contributing to sustainability of the trade and investment relations in this sector with PSD / BIC countries[300], in line with the developed vision.	Description / qualitative
E1	Participants in the sector coalitions have more understanding of the significance / relevance of ICSR for their work and industry	Description / qualitative

[300] PSD countries ('private sector development' countries): developing countries as defined by the Ministry of Foreign Affairs. 'BIC' countries (among emerging markets) are Brazil, India, China. Source: MVO: De IMVO-thermometer. Een onderzoek naar de handelsrelaties tussen Nederlandse MKB'ers en ontwikkelingslanden en opkomende markten, Juni 2013, p. 2. http://mvonederland.nl/sites/default/files/media/Factsheet%20Thermometer%202016%20-%20MVO%20Nederland.pdf

Code	Intended results: Sector Transition Pathway Chemistry	Measuring method/indicator
E2	Participants in the sector coalitions have more experience with the implementation of ICSR in their work	Description / qualitative
E3	Participants in the sector coalitions have more experience with (multistakeholder) cooperation in the field of ICSR projects	Description / qualitative
E4	Coalition participants are ICSR ambassadors for the sector (acting as expert, speak positively about ICSR programme)	Description / qualitative
E5	The sector coalition has actively contact with stakeholders in the sector to achieve expansion ** Broadening = extend the activities of the sector coalition for: 1) more companies are involved outside the coalition; and 2) also the large group of "mainstream" companies is informed on ICSR issues (see 30 % indicator F1 and F2)*	Description / qualitative
E6	The sector coalition has active partnerships with at least one stakeholder focused on future sector approach	Check: yes/no
F1	At least 30 % of the SME entrepreneurs in the sector has been reached (informed) with information about the coalition and the ICSR-transition process.	Number of informed SMEs
F2	At least 30 % of the ICSR-relevant entrepreneurs in the sector (in the coalition or in the 2nd level, or through participation in events) is involved by the activities of the coalition.	Number of entrepreneurs (SMEs) involved
F3	At least 30 % SME entrepreneurs with a direct or indirect business relationship with PSD countries[300] in the sector declare to have knowledge of (be informed about) important ICSR topics in their supply chain.	Share of the target group that declare to have knowledge of important ICSR topics in their supply chain
F4	Parties in the sector evolving new initiatives that contribute to ICSR, following the activities of the industry coalition. …	Amount of new initiatives arising from the sector coalitions
F5	Sustainability of specific supply chains where change projects took place, e.g.: ► More sustainable products and services in the supply chains of the sector with PSD / BIC countries ► More sustainable cooperation (between different actors) in supply chains of the sector with PSD / BIC countries	Description / qualitative

Source: MVO Nederland (2017): Jaarrapportage IMVO-programma 2016, IMVO-programma 'Samen veranderen'. March 2017; in Dutch, translation by the author of this study.

10.1.3 Evaluation

Information on further criteria (except those shown in Table 84) is not available. However, as the recommended ISO 26000 and the GRI guidelines address an almost covering-like thematic spectrum, the evaluation concerning GRI (see 9.1.1 and 9.1.1.4) seems to be applicable.

Table 85: Evaluation of the approach of MVO Nederland, Netherlands

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	MVO refers in its texts to the definitions of the OECD and SusChem, but does not make a choice for one or the other.
Consistency of indicator concept and how it is monitored	No indicators available in detail.
Role of SDGs in the concept	Directly connected, e.g. http://mvonederland.nl/event/sustainable-development-goals-als-kompas-voor-bedrijven-naar-2030
Probability of implementation	Work in progress since 2015 in the Dutch chemical sector
Overall impression	Interesting approach, but more details are needed.

Source: Own compilation

10.2 Interim conclusion on approaches from further non-governmental/non-profit organizations

In accordance with the Advisory Council's proposal, approaches of NGOs/NPOs to sustainable chemistry were examined in the framework of this study. Some of these organizations have already been assessed from another perspective (e.g. GRI and SASB), but at this point here above all those organizations are taken into consideration which have a rather critical view on chemicals' risks. After a first screening of nine Non-governmental/Non-profit Organisations (NGOs/NPOs) (see 14.1.2), no specific approach to sustainable chemistry was found, with the exception of MVO Nederland. But here, detailed informations on criteria are not available.

11 Research approaches

11.1 Quantifiable indicators for sustainable chemistry – results of a research project commissioned by the German Environment Agency

11.1.1 Background information

The German Environment Agency (UBA, 1400 employees) follows a holistic approach regarding sustainable chemistry. Sustainable Chemistry comprises the whole life cycle of a chemical: from production of raw materials, production of chemicals, products and services where chemicals are used, sustainable waste management and the effects on the environment and health including human biomonitoring.

Key areas of UBA daily work are amongst others scientific exertion, the enforcement of environmental law – for example the Chemicals Act – and providing information to the general public about environmental protection issues. The divisions of UBA (I Environmental Planning and Sustainability Strategies, II Environmental Health and Protection of Ecosystems, III Sustainable Production and Products, Waste Management, IV Chemical Safety and E German Emissions Trading Authority) cover most environmental aspects of sustainability and some social and economic aspects as well (see UBA's organizational structure[301] and the flyer "Who we are. What we do."[302]). In cooperation with international organizations and based on the know-how of its divisions UBA is developing proposals for sustainable development like science-based recommendations for the improvement of environmental instruments including legislation.

Division IV is concerned with chemical substances and their effects on, and risks to, ecosystems and human health. The division IV plays an important role in the enforcement of law in the field of industrial chemicals, plant protection products, medicinal products, and washing and cleansing agents. Within UBA the section International Chemicals Management (IV 1.1) has the lead regarding sustainable chemistry. Concerning sustainable chemistry, section IV 1.1 is amongst others developing criteria and general principles for sustainable chemistry, publishing guidelines on sustainable chemicals, their life cycle aspects and on indicators for sustainable chemistry, supporting the business model of chemical leasing as well as organizing information exchange, e.g. via conferences on Sustainable Chemistry. Additionally, UBA is dealing with many aspects in chemicals management e.g.: If a risk to human health or the environment exists, it recommends conditions of use, use restrictions or bans. UBA is responsible of the hazardous substances data pool which provides the public with data on over 140.000 substances. International cooperation of UBA include SAICM and conventions like Stockholm, Basel, Rotterdam or Minamata.

The work of division III revolves around environment and health protection in technology, production and consumption. This comprises Best Available Techniques (BAT) for the production of chemicals as well as solutions to specific problems in branches of industry where chemicals are used e.g. production of pulp and paper or production of textiles and leather. UBA considers criteria like reduction of emissions to air and to water, resource conservation and material cycles, e.g. low-waste technology and, use of less hazardous substances, different raw materials including biomass and carbon dioxide, energy efficiency, and safety of installations. In the context of sustainable chemistry UBA gets in dialogues with industry branches, supports countries like India, Israel or Russia on their way to more sustainable production, has joined the partnership for sustainable textiles and is funding innovative demonstration plants for a more environmental sound production. UBA is involved in eco-design, the development of indicators and methods for the assessment of sustainability e.g. life cycle assessment of

[301] https://www.umweltbundesamt.de/en/the-uba/about-us/organizational-structure-of-the-uba

[302] https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4006.pdf

products and the award criteria of the eco-label "Blue Angel" which can include requirements regarding process chemicals as well as of the European eco-label.

In addition, the divisions I, II and E are amongst others dealing with sustainability strategies, climate change, renewable energy resources, environmentally friendly mobility, protecting water, soil, air and ecosystems and emissions trading. These are all aspects with interfaces to sustainable chemistry. Experts from all UBA divisions are working together to develop solutions or publications like “Germany 2050 – A Greenhouse Gas-Neutral country”.

11.1.2 Project ‘Reduction of resource consumption in the chemical industry by means of sustainable chemistry’

In a separate research project commissioned by the German Environmental Agency,[303] a set of finally 25 quantifiable indicators for sustainable chemistry grouped under six **core criteria** has been developed:

i. Minimization of impacts caused by products and production processes
ii. Minimization of negative impacts on the environment, energy and resources of chemicals that are used in production and application processes
iii. Optimization of production and product design considering the entire life cycle through technical innovation and knowledge transfer and through optimized integration of environmental, economic and social aspects in business processes
iv. Minimization of health hazards of substances, production and products
v. Creation of economic benefits through environmental investments and sustainable cooperation
vi. Optimized integration of environmental, economic and social aspects in business processes in order to improve transparency, education, social standards, dialogue and international cooperation

The target group for the application of these indicators is companies that produce or use chemicals. The indicators are intended to evaluate the use of new products and innovative materials (substitution measures) and optimized production processes or a combination of substitution and process optimization in an integrated approach, taking a broad range of sustainability aspects into account. The application of the indicators provides a first quantitative assessment of whether a measure has led to more sustainability. The assessment is based on data that can be collected in the company itself. [304]

The 25 criteria proposed by Joas et al. 2016[305] correspond very well with the criteria established in GRI G4’s specific standard disclosure and the SDGs, see Table 86.

[303] Anke Joas, Veronika Abraham, Markus Blepp, Dirk Bunke: Beiträge zur Nachhaltigkeitsstrategie: Minderung des Ressourcenverbrauchs in der Chemiebranche durch Instrumente der nachhaltigen Chemie – Zwischenbericht 3 zu Arbeitspaket 4, Mai 2016. FKZ 3713 93 425, unpublished. In German, translation performed by the author of this report.

[304] „Die Indikatoren sollen dazu dienen, den Einsatz neuer Produkte und innovativer Materialien (Substitutionsmaßnahmen) und optimierte Produktionsprozesse oder eine Kombination aus Substitution und Prozessoptimierung in einem integrierten Ansatz unter Berücksichtigung einer breiten Palette von Nachhaltigkeitsgesichtspunkten zu bewerten. Die Anwendung der Indikatoren liefert als Ergebnis eine erste quantitative Einschätzung, ob eine Maßnahme zu mehr Nachhaltigkeit geführt hat. ... Grundlage der Einschätzung sind Daten, die im Unternehmen selber erhoben werden können.“

[305] Anke Joas, Veronika Abraham, Markus Blepp, Dirk Bunke: Beiträge zur Nachhaltigkeitsstrategie: Minderung des Ressourcenverbrauchs in der Chemiebranche durch Instrumente der nachhaltigen Chemie. Teil: Wie messen? Der Indikatorensatz „Parameter der nachhaltigen Chemie“, 10.08.2016 (12 pages), and english version (5 pages)

Table 86: Comparison of 25 quantifiable indicators for sustainable chemistry by Joas et al. (2016)[305] with criteria established in GRI G4's specific standard disclosure

GRI G4			Joas et al. 2016[303]		
Aspect	**#**	**Indicator**	**NC**	**Indicator[1]**	**Target unit[2]**
General Standard Disclosures					
Section: Organizational profile	G4-8	Markets served	NC 19	Market presence	Market share in % (sales enterprises divided by sales market)
	G4-10	Total number of employees by type	NC 23	Total percentage of women	% of persons employed (related to the spatial system boundary)
	G4-11	Collective bargaining agreements	NC 24	Percentage of women in management positions	% of employees in managerial positions (related to the spatial system boundary)
Specific Standard Disclosures					
	G4-DMA	Disclosures on management approach (DMA)	NC 21	Certification according to ISO, EMAS etc.	List of certifications
Category: Economic					
Economic performance	G4-EC1	Economic value	NC 18	Intensity of capital expenditure to protect the environment and/or resources	% of total investments and € per year
Category: Environment					
Materials	G4-EN1	Materials by weight or volume	NC 2	Raw material consumption	kg; can also be expressed in terms of loss potential (WPKRA) according to LCA
			NC 3	Raw material intensity/ productivity	kg raw material/kg product or kg product/kg raw material
	G4-EN2	Recycled input materials	NC 4	Percentage of renewable raw materials for material use	% of total raw material input
Energy	G4-EN3	Energy consumption (Scope 1 + 2)	NC 5	Energy expenditure	kWh or MJ (taking into account all energy resources, i.e. renewable and non-renewable ones (upper calorific value) can also be expressed in terms of loss potential (WPKEA) according to LCA

GRI G4			Joas et al. 2016[303]		
Aspect	**#**	**Indicator**	**NC**	**Indicator[1]**	**Target unit[2]**
Water	G4-EN5	Energy intensity	NC 6	Energy intensity/ productivity	kWh/kg product or kg product/kWh
	G4-EN8	Water withdrawals by source	NC 7	Total water requirements	m^3 / also conceivable as water scarcity potential (WVP m^2 H_2Oe) according to LCA
	G4-EN10	Water recycled and reused	NC 8	Percentage of recovered water	% of total water consumption
Emissions	G4-EN15	GHG emissions (Scope 1)	NC 1	GHG emissions	kg of CO_2 equivalents over life cycle (ideally, GWP_{100} according to LCA)
	G4-EN16	GHG emissions (Scope 2)	NC 1	GHG emissions	
	G4-EN17	GHG emissions (Scope 3)	NC 1	GHG emissions	
	G4-EN20	Ozone-depleting substances (ODS)	NC 9	Pollutant emissions into the air	amount/year (e.g. µg/a or µg/kg product), can also be expressed in terms of the sum indicator "acidification potential" (kg SO_2 equivalents) and toxic injury caused by fine dust (AFP) kg PM_{10} equ. according to LCA
	G4-EN21	NOx, SOx and other emissions	NC 9	Pollutant emissions into the air	
Effluents & waste	G4-EN22	Water discharge	NC 10	Pollutant emissions into water and into soil	amount/year (e.g. µg/a or µg/kg product), can also be expressed in terms of the sum indicator „aquatic and terrestrial eutrophica-tion potential" (EP) (kg PO_4^{3-}e) according to LCA
	G4-EN23	Waste by type and disposal method	NC 11	Waste volume	t/a or t/t product
	G4-EN25	Hazardous waste	NC 12	Percentage of hazardous waste	% of waste emissions
Supplier Environmental Management	G4-EN32	New suppliers screened using environmental criteria	NC 20	Share of suppliers and contractors audited for their compliance with human rights and environmental aspects	% of all suppliers and contractors (along the entire value chain)

GRI G4			Joas et al. 2016[303]		
Aspect	**#**	**Indicator**	**NC**	**Indicator[1]**	**Target unit[2]**
Category: Social					
Sub-category: Labour practices & decent work					
Occupational health & safety	G4-LA6	Rates of injury, occupational disease, lost days, absente-eism and work-related fatalities	NC 15	Work-related accidents	total/year
	G4-LA7	Workers with high incidence risk of diseases	NC 16	Occupational diseases	% of persons employed
Training & education	G4-LA9	Average hours of training for employees	NC 22	Staff training and education	h/employee/year (related to the spatial system boundary)
	G4-LA12		NC 25		
Sub-category: Human rights					
Supplier Human Rights Assessments	G4-HR10	New suppliers screened for human rights	NC 20	Share of suppliers and contractors audited for their compliance with human rights and environmental aspects	% of all suppliers and contractors (along the entire value chain)
Sub-category: Product responsibility					
Customer health & safety	G4-PR1	Health and safety impact assessments of products and services	NC 14	Percentage of hazardous substances (as indicator for substitution of hazardous substances)	% in product mass and classification according to CLP and further hazardous characteristics (such as PBT, endocrine disruption); calculation of environmental hazard and health hazard potential (such as Freshwater Toxicity (CF); Human Toxicity Potential (HTP cancer, HTP non-cancer; or hazardous substances potential (HSP)3)
Product & service labelling	G4-PR3	Product and service informa-tion required for labelling	NC 13	Sustainability information on production	% of product mass
No GRI category					

GRI G4			Joas et al. 2016[303]		
Aspect	#	Indicator	NC	Indicator[1]	Target unit[2]
			NC 17	Economic benefits through sustainable action	€/year
				Other benefits	Non-quantifiable

1 Direct + indirect effects of sustainability tools

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

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

Own compilation, using the following source: Beiträge zur Nachhaltigkeitsstrategie: Minderung des Ressourcenverbrauchs in der Chemiebranche durch Instrumente der nachhaltigen Chemie. Teil: Wie messen? Der Indikatorensatz „Parameter der nachhaltigen Chemie", 10.08.2016 (12 pages), and english version (5 pages): How can sustainability in chemistry be measured? The indicator set and the map of Sustainable Chemistry.

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

The indicator set does not provide any individual evaluations in detail. This would require the coverage of the materials' up- and downstream chains. There are other appropriate instruments (LCA, product carbon footprints, OEF and others) for these more extended and detailed investigations. However, the values derived on the basis of the indicators (e.g. relating to energy expenditure) can be used for such follow-up reviews. Hence, the current state of the method discussion on other assessment tools (in particular LCA) was taken into account in developing the indicators."[305]

12 Conclusions derived from the analysis

12.1 Definitions

The study's objectives were to gain a better understanding of different definitions and concepts of sustainable chemistry and to interpret the consequences of these various approaches.

The analysis shows gaps in the definition and understanding of sustainable chemistry:

- In the past, green chemistry and sustainable chemistry have been regarded as synonyms. Today, a much more precise distinction is made between the two approaches.
- OECD has set standards with its definition of sustainable chemistry as a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services and also as a process that stimulates innovation across all sectors. Its description of sustainable chemistry has a strong perception, because of the particular role of this international organization in providing science-based tools for policy-making [Blum et al., 2017].
- Industry too has no uniform definition of sustainable chemistry. ICCA, WBCSD, TfS and Chemie^3 refer more or less clearly to the triple bottom line approach. The European Technology Platform for Sustainable Chemistry (SusChem) cites the OECD definition of sustainable chemistry, proposes an LCA-approach and stresses the need for acceptance by society.
- The evaluation of the approach of six chemical companies – all global players – shows that only one (Dow Chemical) has a clear understanding and definition of sustainable chemistry: "Green chemistry is a set of principles to design, but sustainable chemistry looks beyond only a science. It is a catalyst for change, an innovative approach to problem-solving and a long-term solution to global sustainability challenges. … Ultimately, chemistry and collaboration – and people – have the power to bend that straight line to a more positive point in the future, where nature and therefore human prosperity are in balance." Though not explicitely addressing social aspects in detail, this definition is close to the holistic approach that OECD developed and Blum et al. [2017] proposed with "the challenges in terms of social conditions, the inclusion of research, science and culture, and a successful long-term and sustainable way of management respecting the capacity-limits of our planet."

Working towards a commonly agreed definition of sustainable chemistry which clearly indicates the final goal – a transformation of society that respects the capacity-limits of our planet – **is recommended**.

12.2 Indicators and metrics

Current reporting on sustainability progress in companies or sectors is mainly focussed on economic, ecological and social aspects. The development of indicators for measuring progress is an ongoing process, as the analysis of the chemical industry's approaches show.

WBCSD offers some guiding documents for environmental aspects in the chemical industry, and is frontrunner with its guideline of 2016 on social life cycle metrics (its development was co-chaired by BASF, DSM and Solvay). ICCA periodically reviews its metrics to determine the need for any changes. SusChem will address sustainability more comprehensively across environmental, societal and economic issues along the whole value chain in conjunction with its stakeholders. Chemie^3 has published its catalogue of 40 indicators in late 2016. Since methodological questions and the application of the criteria are still open, the cannot be evaluated. The TfS approach to sustainability or to sustainable supply chains is of interest, but indicators are not available for the public.

The three UNIDO projects selected for evaluation show that their concept covers broad parts of the concept of sustainable chemistry defined by the German Environment Agency, like improvement of

resource efficiency, environmentally friendly production and use of chemicals, the inclusion of the entire life cycle of a product.

In order to prevent greenwashing or filtering only those indicators that allow organisations to be seen in only a good light, and in order to benchmark, reporting standards are a basic requirement. The Global Reporting Initiative is the most used standard worldwide. In this study, six companies were selected for analysis, five of them have published a Sustainability/CSR report (or integrated report) in accordance with GRI 4 guidelines. The concept of indicators, criteria and metrics for reporting is therefore predefined. However, companies are allowed to use additional metrics to control their sustainability goals and four of them did so:

- AkzoNobel used additional metrics such as eco-premium solutions with downstream benefits
- DSM used additional metrics such as Eco+ and People+ solutions with downstream benefits
- Dow Chemical used additional metrics such as Breakthrough: Evaluation of innovations for their impact on alleviating world challenges (energy and climate change, water, food, housing and health), measured level of support among key value chain and stakeholder representatives and sum of people whose sustainable development challenges have been positively impacted
- PTTGC uses societal impact indicators such as position in Dow Jones Sustainability Indices (DJSI) and customer and supplier satisfaction.

It is recommended to follow closely the application of WBCSD's Social Life Cycle Metrics for Chemical Products. Currently there is only one case study available, but it can be expected that the co-chairing and supporting companies will applicate this guideline for instance for their next sustainability/CSR-reports.

It is recommended that the evaluation of chemical company approaches is continued, looking at how they address the SDGs (especially social challenges) and other global challenges besides climate change, e.g. resource depletion. The availability of and the supply with key elements that are critical for society functions, e.g. refractory metals and rare earths, used in chemical processes (catalysis) and final products (electronics, etc.), is a major challenge for the chemical industry. The aim is to develop widely accepted criteria and indicators for the concept of sustainable chemistry.

12.3 Reporting and rating

To ensure transparency and measure corporate performance, GRI, SASB and others offer reporting and measuring concepts that differ mainly in the target group: Shareholders (SASB, IIRC) or stakeholders (GRI). With its G4 Guidelines, GRI has included supply chain and governance aspects, such as reporting indicators. However, GRI does not explicitly ask for the company's contribution to other global challenges, with the exception of climate change. SASB's approach to chemicals is mainly focussed on green chemistry, supplemented with some societal aspects such as political spending, and neglecting others.

Approaches in sustainability rating and socially responsible investment are naturally oriented to shareholder expectations. However, as Constable points out[306]: "Investors also vary in the attention they give to sustainability metrics. It would be wrong to generalize too much, but I think it's fair to say that the investor community is mostly known for its ability to either make large returns on investment over a short period of time or for its ability to make predictable returns over time. In the world of sustainability, the time horizons are generally longer than investor attention, and in most cases, there are

[306] "David Constable: Green chemistry & engineering is a way of thinking & requires a collection of diverse skills to excel. Chemical Weekly February 25, 209-212, 2014. http://www.greenchemistree.co.in/pdf-docs/IGCW%202013/David%20Constable%20Interview.pdf

not such large short-term sustainability risks that would outweigh other more traditional business risks of greater concern to the investor community."

Nevertheless, different sustainability indices are available which investors can use as a source of information. In this study, two concepts are described: The Dow Jones Sustainability Index (DJSI) and the MSCI ACWI Sustainable Impact Index. Positioning in the DJSI is an incentive for innovative chemical companies (e.g. AkzoNobel/see sub-chapter 8.1.1.3, PTTGC/see sub-chapter 8.3.1.2). The MSCI ACWI Sustainable Impact Index probably has more potential for application on sustainable chemistry as it focusses – consideration of ESG criteria and excellent operational performance provided – focus on the impact of chemical companies with regard to the SDGs.

It is recommended that further developments in the area of reporting and rating standards are monitored with particular attention to the contribution of sustainable chemistry to societal progress.

12.4 Holistic approach

Sustainable chemistry is one of the key enablers for reaching the Sustainable Development Goals (SDGs). Chemical industry is a provider of materials and solutions for a large range of downstream sectors and applications. It has a large potential impact on energy and resource efficiency, lifetime, functionality, recyclability and safety of products in virtually all industrial and consumer areas. Its solutions are not only more environmentally friendly than alternatives already on the market, but promote or enable social changes for a better life for all while respecting the capacitylimits of the planet.

Blum et al. [2017], regarding sustainable chemistry as a holistic approach, proposed some promising approaches including:

- Social conditions
- Research, science and culture
- Successful, long-term and sustainable way of management respecting the capacity-limits of our planet.

It is recommended that a broader discussion on the indicators and metrics of these aspects is started. First approaches have already been developed e.g. by AkzoNobel, DSM and Dow Chemical (see sub-chapter 12.2). It should be further observed how these approaches are applied in reality and what results are achieved.

12.5 Expanding of mapping

In terms of the basics of sustainability, there is an information gap with regard to sustainable chemistry, circular economy (resource recovery and resource conservation), and education and teaching.

It is recommended that mapping is extended to these areas in order to identify relevant actors and further approaches for mainstreaming the Sustainable Chemistry concept.

12.6 Recommendations for future areas of work for the ISC_3

Achievement of Sustainable Chemistry is both a process and an aim, ensuring the achievement of the sustainable development goals. There are many initiatives for sustainable chemistry throughout Europe and the world and the demand for collaboration and cooperation is high. This is why a process was initiated to establish the International Sustainable Chemistry Collaborative Centre (ISC_3).

The ISC_3 is intended to become the central focal point in sustainable chemistry for all stakeholders (industry, academia, politics, consumers …) and should raise awareness towards sustainable chemistry in all fields. All partners along the value chain will be included in this process. Clearly, the ISC_3 should not duplicate existing activities but instead build on them.

In view of the results of this study, the following tasks are recommended for the further work of the ISC_3:

- To work on a **commonly agreed definition of sustainable chemistry** which clearly indicates the final goal – a transformation of society that respects the capacity-limits of our planet.
- To **continue the evaluation of chemical company approaches**, looking at how they address other global challenges apart from climate change, e.g. resource depletion. The availability of and the supply with key elements that are critical for society functions, e.g. refractory metals and rare earths, used in chemical processes (catalysis) and final products (electronics, etc.), is a major challenge for chemical industry.
- To **monitor further developments in the area of reporting and rating standards** with regard to the contribution of sustainable chemistry to societal progress.
- To **introduce a broader discussion on the indicators and metrics** of the following aspects: Social conditions, research, science and culture, successful long-term and sustainable way of management respecting the capacity-limits of our planet.
- To observe further how first approaches developed e.g. by WBCSD, AkzoNobel, DSM and Dow Chemical are **applied in reality** and what results are achieved.
- To **expand mapping** to these areas in order to identify relevant actors and further approaches for mainstreaming the Sustainable Chemistry concept.

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14 List of Annexes

14.1 Annex I: Long lists

14.1.1 Further potential candidates from industry

Name	(Main) URL	Region	Headquarter	Short description
Air Liquide	https://www.airliquide.com/group/acting-responsibly	Europe	France	Acting Responsibly
Air Liquide	https://www.airliquide.com/file/46761/download?token=LCnRXCL2	Europe	France	2015 REFERENCE DOCUMENT Including the Sustainable Development Report
BASF	https://www.basf.com/en/company/sustainability.html	Europe	Germany	Sustainability at BASF
BASF	https://www.basf.com/en/company/sustainability/whats-new/sustainability-news/2016/report-2015-published.html	Europe	Germany	Sustainability Report published
Bayer AG	http://www.bayer.com/en/sustainability.aspx	Europe	Germany	Bayer-Science for a better life
Bayer AG	http://report.basf.com/2015/en/servicepages/downloads/files/BASF_Report_2015.pdf	Europe	Germany	Bayer Sust. Rep. 2015
Bayer AG	http://report.basf.com/2015/en/servicepages/downloads/files/gri_index_basf_ar15.pdf	Europe	Germany	Bayer Ann. Rep. 2015
Bayer AG	http://report.basf.com/2015/en/servicepages/downloads/files/entire_basf_ar15.xls	Europe	Germany	Bayer Ann. Rep. 2015 Tables
Clariant AG	http://static.globalreporting.org/report-pdfs/2016/568b34d5dc2f6945d6a6f235cbdb1dab.pdf	Europe	Switzerland	Sust. Rep. 2016
Clariant AG	http://static.globalreporting.org/report-pdfs/2015/c917daf23dd4b9c9fb6bc4106f1a916b.pdf	Europe	Switzerland	Sust. Rep. 2014
Clariant AG	http://www.clariant.com/~/media/Files/Corporate/Events/2015/ECS/Emulsion_Polymerization_Providing_application_benefits_along_the_value_chain.pdf	Europe	Switzerland	Value Chain
Clariant AG	https://www.clariant.com/~/media/Files/Corporate/DiscoverValue/EcoTain/Portfolio_Value_Program_Case_Study.pdf	Europe	Switzerland	Case study
Evonik Industries	http://corporate.evonik.com/en/responsibility/cr-at-evonik/cr-strategy/Pages/default.aspx	Europe	Germany	Sustainability Strategy
Evonik Industries	http://static.globalreporting.org/report-pdfs/2016/2f8c65f8a2d1e7ba1089e5091fe41bb8.pdf	Europe	Germany	Sust. Rep. 2015
Evonik Industries	http://static.globalreporting.org/report-pdfs/2015/280b771abc3dcfab695cecc677d09ad6.pdf	Europe	Germany	Sust. Rep. 2014
INEOS	http://www.ineos.com/sustainability/	Europe	Switzerland	INEOS Sustainability
INEOS	http://static.globalreporting.org/report-pdfs/2015/334870e6b1630af1cdca3a6afdbe503f.pdf	Europe	Switzerland	Sust. Rep. 2014
INEOS	http://www.ineos.com/globalassets/ineos-group/businesses/ineos-bio/she/rs398_ineos-bio-life-cycle-assessment.pdf	Europe	Switzerland	LCA
LANXESS	http://static.globalreporting.org/report-pdfs/2014/fa49db3acbf4a7841ab50d0fc28e017f.pdf	Europe	Germany	Sust. Rep. 2013
LANXESS	http://lanxess.com/en/media-download/gj-2015-geschaeftsbericht-2015_de/	Europe	Germany	Sust. Rep. 2014
Pfizer	https://www.pfizer.com/files/investors/financial_reports/annual_reports/2015/index.htm	Europe	UK	Ann. Rep. 2015, Index
Pfizer	https://www.pfizer.com/files/investors/financial_reports/annual_reports/2015/assets/pdfs/pfi2015ar-entire-site.pdf	Europe	UK	Ann. Rep. 2015

Name	(Main) URL	Region	Headquarter	Short description
Pfizer	https://www.pfizer.com/files/investors/financial_reports/annual_reports/2015/assets/pdfs/pfi2015ar-gri-reference.pdf	Europe	UK	Ann. Rep. 2015, GRI-Index
Royal Dutch Shell	http://www.shell.com/sustainability.html	Europe	Netherlands	Royal Dutch Shell Sustainability
Royal Dutch Shell	http://www.shell.com/sustainability/sustainability-reporting-and-performance-data/how-we-report/reporting-standards-and-guidelines.html	Europe	Netherlands	How we report
Royal Dutch Shell	http://reports.shell.com/sustainability-report/2015/servicepages/downloads/files/entire_shell_sr15.pdf	Europe	Netherlands	Sust. Rep. 2015
Royal Dutch Shell	http://reports.shell.com/sustainability-report/2015/servicepages/downloads/files/gri_index_shell_sr15.pdf	Europe	Netherlands	GRI-Index 2015
Solvay SA	http://www.solvayinstitutes.be/pdf/reports/Annual_report%202015.pdf	Europe	Belgium	Ann. Rep. 2015
Solvay SA	http://www.solvay.de/de/binaries/Solvay-Jahresbericht-2014-09-184058.pdf	Europe	Belgium	Ann. Rep. 2014
The Linde Group	http://www.the-linde-group.com/en/corporate_responsibility/index.html	Europe	Germany	Corporate Responsibility
The Linde Group	http://corporateresponsibility.linde.com/cr-report/2015/the-report/about-this-report.html	Europe	Germany	Aboput CR-Report
The Linde Group	http://corporateresponsibility.linde.com/cr-report/2015/servicepages/downloads/files/Linde_CR_Report_2015.pdf	Europe	Germany	CR-Report 2015
The Linde Group	http://corporateresponsibility.linde.com/cr-report/2015/servicepages/downloads/files/TLG_CR_2015_Value_chain.pdf	Europe	Germany	Value Chain 2015
Ecolab Inc.	www.ecolab.com/sustainability	North America	USA	Ecolab = global leader in water, energy and hygiene technologies and services
Ecolab Inc.	http://static.globalreporting.org/report-pdfs/2016/6e8b68ceb28fb88bd1eee114198272dc.pdf	North America	USA	GRI G4-report 2015
ExxonMobile	http://corporate.exxonmobil.com/en/community/corporate-citizenship-report	North America	USA	Corporate Citizenship
ExxonMobile	http://corporate.exxonmobil.com/en/community/corporate-citizenship-report/about-this-report/managing-sustainability-issues	North America	USA	Definiton of sustainability
ExxonMobile	http://uberflip.cdntwrk.com/files/aT03MDUwMTgmdj0xJmlzc3VlTmFtZT1leHhvbm1vYmlsLWNjci0yMDE1JmNtZD1kJnNpZz05MWQyMGY0YjRmNWJiYTYzNDkzYWE4ODU1OGY0NzEzMQ%253D%253D	North America	USA	CSR Report
ExxonMobile	https://www.greenbiz.com/article/exxon-olympics-and-greenwashing-20	North America	USA	Critics
ExxonMobile	http://corporate.exxonmobil.com/en/community/corporate-citizenship-report/managing-climate-change-risks/developing-solutions-reducing-ghg-emissions-for-customers	North America	USA	Innovative chemical materials
Lubrizol	https://www.lubrizol.com/Our-Company/Fact-Sheets/Lubrizol-Corporate.pdf	North America	USA	Corp.
Lubrizol	https://www.lubrizol.com/CorporateResponsibility/Scorecard.html	North America	USA	Global Sustainability Scorecard Data
Lyondellbasell	https://www.lyondellbasell.com/en/sustainability/	North America	USA	Lyondellbasell Sustainability

Name	(Main) URL	Region	Headquarter	Short description
Lyondellbasell	https://www.lyondellbasell.com/globalassets/investors/company-reports/2015/lyb_annualreport_2015.pdf?id=17014	North America	USA	Ann. Rep. 2015
PPG Industries Inc.	http://sustainability.ppg.com/Home.aspx	North America	USA	Sustainability
PPG Industries Inc.	Sustainability: 2020 Goals http://sustainability.ppg.com/getdoc/052ff805-3441-40ad-93a8-2f797b5ddfa4/Goals.aspx	North America	USA	Sustainability goals
PPG Industries Inc.	http://sustainability.ppg.com/Environment/Sustainable-Products.aspx	North America	USA	Sustainable products
Sigma-Aldrich Corp / MilliporeSigma	https://www.sigmaaldrich.com/globalcitizenship.html	North America	USA	Global Citizenship
Sigma-Aldrich Corp / MilliporeSigma	http://static.globalreporting.org/report-pdfs/2014/f34b6d941868d5956889e2863d528244.pdf	North America	USA	Sust. Rep. 2013
Formosa Plastics	http://www.fpcusa.com/citizenship.html	Asia	Taiwan	FPC Corporate Citizenship
LG Chem	http://www.lgchem.com/global/sustainability/sustainability-introduction/principle	Asia	South Korea	LG Chem Sustainability
LG Chem	http://static.globalreporting.org/report-pdfs/2015/b860b74c3ececb4d0bd6730f66ef1985.pdf	Asia	South Korea	Sust. Rep. 2014
LG Chem	http://static.globalreporting.org/report-pdfs/2014/818b97b8b5156b919d8f27eabfd38add.pdf	Asia	South Korea	Sust. Rep. 2013
Mitsubishi Chemical	http://www.mitsubishichem-hd.co.jp/english/sustainability/	Asia	Japan	Management of Sustainability (MOS)
Mitsubishi Chemical	http://www.mitsubishichem-hd.co.jp/english/csr/download/pdf/16.pdf	Asia	Japan	CSR-Rep.
Mitsui Chemicals	http://www.mitsuichem.com/csr/index.htm	Asia	Japan	Corporate Social Responsibility
Mitsui Chemicals	http://static.globalreporting.org/report-pdfs/2015/7ebf578677832de3ab31fe583c99c5e3.pdf	Asia	Japan	Sust. Rep. 2014
Saudi Basic Industries Corporation	https://www.sabic-ip.com/gep/en/AboutUs/Sustainability/sustainability.html	Asia	Saudi Arabia	SABIC Sustainability
Saudi Basic Industries Corporation	https://www.sabic.com/corporate/en/images/SABIC-Sustainability-Report-2015-ENG_tcm12-18246.pdf	Asia	Saudi Arabia	Sust. Rep. 2015
Saudi Basic Industries Corporation	https://www.sabic.com/corporate/en/images/SABIC-Sustainability-Report-Executive-Summary-2015-ENG_tcm12-19175.pdf	Asia	Saudi Arabia	Exec. Sum SR 2015
Sumitomo Chemical	http://www.sumitomo-chem.co.jp/english/csr/	Asia	Japan	Corporate Social Responsibility
Sumitomo Chemical	http://static.globalreporting.org/report-pdfs/2015/e028470f410c55cc30a5ab30b058da54.pdf	Asia	Japan	Sust. Rep. 2014
Sumitomo Chemical	http://static.globalreporting.org/report-pdfs/2014/ea19c8513366c1e73b2f499af079be0c.pdf	Asia	Japan	Sust. Rep. 2013
Braskem	http://www.braskem.com/site.aspx/chemistry-sustainable-USA	Latin America	Brazil	Sust. Chem.
Braskem	http://static.globalreporting.org/report-pdfs/2015/47a08f54592c1e4f9367941824b76145.pdf	Latin America	Brazil	Sust. Rep. 2014

Own compilation.

14.1.2 Non-governmental/non-profit organisations (NGOs/NPOs)

The following NGOs/NPOs were examined with regard to their approach to sustainable chemistry:

- International Chemical Secretariat, Gothenburg, Sweden
- European Environmental Bureau (EEB), Brussels, Belgium
- Healthcare without Harm Europe, Brussels, Belgium
- GREENPEACE
- PAN – Pesticide Action Network
- EDC Free – Stop hormone disrupting chemicals
- ESDO (Environment and Social Development Organization)
- European Chemical Regions Network (ECRN), Brussels, Belgium
- Industriegewerkschaft, Bergbau, Chemie, Energie (IG BCE), Hanover, Germany

Most of them are working on hazardous substances and (in Europe) on REACH or are participants in larger initiatives (e.g. ECRN/SusChem, IG BCE/Chemie[3]) and have not developed their own criteria for sustainable chemistry.

14.2 Annex II: The Green Chemistry Checklist

"The Checklist was developed by the Michigan Green Chemistry Roundtable in cooperation with the Green Chemistry and Commerce Council, and builds on the GC3 Policy Statement on Green Chemistry."[307]

Table 87: Michigan Green Chemistry Roundtable Green Chemistry Checklist, v.1.0, 2014

Area	Activity	Possible metrics
Education	Identify and support Green Chemistry training opportunities for relevant employees at the time of hire	Number of new hire trainings; number of times per year offered; number of new hires taking training; percent of relevant new hires completing the training
	Identify and support regular Green Chemistry training opportunities for all relevant employees	Number of continuing education trainings offered; number of employees taking trainings
	Identify and support Green Chemistry training or learning opportunities for suppliers	Number of continuing education training/learning opportunities offered; number of suppliers engaged; number of supplier employees taking seminars/ trainings, etc.
	Work with sector trade associations or other groups to identify seminars and training for sector members	Number of associations approached; number of trainings offered; number of sessions at conferences
	Recognize staff doing outstanding work in Green Chemistry and Engineering including the develop- ment of safer chemicals, products and processes	Employee award created; number of employees recognized
	Recognize suppliers doing outstanding work in Green Chemistry and Engineering	Number of suppliers recognized

[307] Michigan Green Chemistry Roundtable, Green Chemistry Checklist, v.1.0, 2014 http://www.greenchemistryandcommerce.org/assets/media/images/uml%20GC3%20checklist.pdf

Area	Activity	Possible metrics
	including the development of safer chemicals, products and processes	
	Include recognition for Green Chemistry innovators in company compensation considerations	Number of employees recognized; Green Chemistry activity included in compensation reviews where appropriate
Hiring	Include explicit reference to desire for Green Chemistry and Engineering academic training in all relevant job postings	Number of job postings with reference to GC and GE/ all relevant job postings
	Hire candidates with Green Chemistry and Engineering training all things being equal	Number of hirings with experience in GC and GE
	Incorporate Green Chemistry corporate goals and vision into relevant new hire orientation	New hire trainings include Green Chemistry corporate goals
	Include Green Chemistry and Engineering performance requirements in job goals including the development of safer chemicals, products and processes	Number of employees with Green Chemistry and Engineering performance requirements
Support and Communication	Provide co-op internship placements for students working in Green Chemistry and Engineering fields	Number of Green Chemistry/GE student interns; number of GC/GE placement opportunities
	Provide support to local academic institutions to encourage Green Chemistry and Engineering training for students	Number of institutions approached with information
	Work with local academic institutions on innovations needed for a green economy	Number of publicly announced collaborations
	Communicate company Green Chemistry goals to suppliers	Number of meetings/seminars held with suppliers including this topic; inclusion of GC&E goals in CDP, GRI or other relevant B to B communication platforms
	Publicly report on Green Chemistry/Green Engineering progress including the development of safer chemicals, products and processes	Report on innovations in Green Chemistry through the Toxic Release Inventory (TRI) and other public reporting; inclusion of GC&E goals in CDP, GRI or other similar reports; publishing case studies and reports on company progress toward GC/GE
	Provide assistance to suppliers in meeting their Green Chemistry goals	Number of examples; impact of examples (money, waste reduction, etc.)
	Sign the Policy Statement on Green Chemistry in Higher Education	Sent message to GC3 with sign-on
	Become a Corporate Partner of the Green Chemistry Commitment	Signed on as a Corporate Partner with the Green Chemistry Commitment; Worked with the academic signers of the GCC in one or more of the six ways that partners are involved.

Area	Activity	Possible metrics
Design and Innovation	Establish the development of Green Chemistry products and processes as a primary goal of the organization	Broad executive policy promoting green chemistry in place; tracking number of KPI's based on Green Chemistry principles
	Regularly monitor progress toward Green Chemistry goals including greening product lines	Evaluation process in place to monitor progress toward safer chemistry goals including product development; number of product lines greened
	Embed Green Chemistry design criteria in product design guidelines and at each stage gate of product development	Green Chemistry criteria embedded in design guidelines, tools, processes and practices and at each stage gate of development
	Include Green Chemistry criteria in relevant sourcing protocols/specifications/contracts	Language in standard specifications/ protocols/ contracts requiring/rewarding greener chemical products or green chemical manufacturing
	Screen all new chemical ingredients for Green Chemistry attributes	Policy and process in place for screening chemicals
	Devote R and D dollars to Green Chemistry innovation	Dollars devoted to Green Chemistry innovation
	Commercialize products with Green Chemistry advantages over existing chemicals or products	Number of products commercialized; value of products commercialized
	Commercialize inherently green chemicals or products (product designed to be green from the ground up)	Number of green chemical products commercialized
	Commercialize products designed to be restorative or to increase resilience in ecosystems	Number of restorative products commercialized

Source: Michigan Green Chemistry Roundtable, Green Chemistry Checklist, v.1.0, 2014
http://www.greenchemistryandcommerce.org/assets/media/images/uml%20GC3%20checklist.pdf

14.3 Annex III: Chemie[3]: Progress indicators

Table 88: Chemie[3]: Indicators for measuring progress in sustainabilit in the chemical-pharmaceutical industry [2016; translation by the author]

No.	Short name	Indicator	Calculation/Unit	Reference documents
1	Companies having defined sustainability goals	Share of companies in sector having defined sustainability goals; of them publicly communicated goals	1. Number of companies with defined sustainability goals / Number of answered questionnaires (in percent) 2. Number of companies with publicly communicated sustainability goals / number of questionnaires answered (in percent)	GRI G4: Disclosures on Management Approach (DMA) for all essential aspects
2	Companies having established compliance processes	Share of companies in the sector having established processes to comply with laws and guidelines.	Number of companies with established processes / Number of answered questionnaires (in percent)	GRI G4: Disclosures on Management Approach (DMA) for „compliance“; indicators EN29, SO8, PR9 ISO 19600
3	Companies with sustainability criteria in supplier selection	Share of companies in the sector which take into account sustainability criteria in the selection of suppliers in addition to the classic purchasing criteria price, quality and delivery conditions.	Number of companies with sustainability criteria in the selection of suppliers / Number of answered questionnaires (in percent)	GRI G4: Disclosures on Management Approach (DMA) for the aspects „Supplier Environmental Assessment“, „Supplier Assessment for Labor Practices“, „Supplier Human Rights Assessment“ und „Supplier Assessment for Impacts on Society“
4	Companies with public sustainability communicati on	Share of companies in the sector which publish information on essential (“material”) sustainability issues.	Number of companies with public sustainability communication / Number of answered questionnaires (in percent)	--

No.	Short name	Indicator	Calculation/Unit	Reference documents
5	Companies with regular stakeholder exchange on sustainability issues	Share of companies in the sector with regular stakeholder exchange on sustainability issues	Number of companies in the sector performing regular stakeholder exchange (clients, suppliers, employees, etc.) on sustainability issues / Number of answered questionnaires (in percent)	GRI G4: „Stakeholder Engagement“ (indicator 26)
6	Companies oriented / commited to UN guiding principles for business and human rights or a comparable set of rules	Share of companies in the sector which are oriented towards or committed themselves publicly to the UN Guiding Principles for Business and Human Rights or a comparable set of rules, such as the OECD Guidelines for Multinational Enterprises, the tripartite ILO Declaration on Multinational Enterprises and Social Policy or the UN Global Compact	1. Number of companies in the sector with commitment to human rights / Number of answered questionnaires (in percent) 2. Number of companies communicating publicly / Number of answered questionnaires (in percent)	Cf. Section 289c (2) of the German Commercial Code (in force at the beginning of 2017)
7	Social partnerships	Social partnerships (joint social partner organizations, number of events and agreements between the social partners at sector level)	Number of joint events	Cf. GRI G4: Disclosures on Management Approach (DMA) for the aspects „employer-employee relationship“
8	Average wage per employee	Average wage per employee in the sector	in euro	Cf. GRI G4: aspect „market presence“; indicator EC5
9	Collective bargaining agreements – Company	Share of companies in the sector with area tariff binding to the total number of companies in the sector	in percent	--
10	Collective bargaining agreements – Employees	Share of employees in fixed-rate companies on the total number of employees in the sector	in percent	--
11	Companies with a works council	Share of the companies in the sector with works council to the total number of companies in the sector	in percent	--

No.	Short name	Indicator	Calculation/Unit	Reference documents
12	Employees represented by a works council	Share of employees represented by a works council in proportion to the total number of employees in the sector	in percent	--
13	Companies with collective bargaining / company pension scheme	Share of employees in the sector under collective bargaining and / or company pension schemes to the total number of employees in the sector	1. Number of employees under collective bargaining / number of employees (in percent) 2. Number of employees with employer financed company pension schemes / number of employees (in percent)	--
14	Companies with an agreement on aging- and age-appropriate work	Share of the companies in the sector with agreements on aging- and age-appropriate work (e.g. within the framework of the "Working Life and Demography" collective agreement) to the total number of companies in the sector	Number of companies with agreements on aging- and age-appropriate work / Number of answered questionnaires (in percent)	Cf. GRI G4: aspect „Training and education“; indicator LA10
15	Companies offering health care and counseling services	Share of the companies in the sector offering health care and counseling services (e.g. within the framework of the "Working Life and Demography" collective agreement) to the total number of companies in the sector	Number of the companies offering health care and counseling services / Number of answered questionnaires (in percent)	Cf. SASB Chemical Standard: aspect „Health, Safety, and Emergency Management “; indicator RT0101-21
16	Companies with flexible working time models	Share of the companies in the sector offering flexible working time models (e.g. part-time, flexible working hours, mobile work)	Number of companies offering flexible working time models / Number of answered questionnaires (in percent)	--
17	Offered apprenticeships	Number of offered apprenticeships in the sector	Number of offered training places	Cf. GRI G4: aspect „Training and education“; indicator LA9
18	Takeover rate	Takeover rate: Number of trainees taken over in proportion to the number of trainees in the sector who have been ready to be taken over	Number of trainees taken over / number of trainees who have been ready to be taken over Result: rate in percent	--

No.	Short name	Indicator	Calculation/Unit	Reference documents
19	Places for training preparatory measures	Number of places for training preparatory measures in the sector	Number of places for training preparatory measures	--
20	Investment in further training and development	Investments in the sector in further training and development (in euro)	Investments in the sector in further training and development / Number of employees (in euro)	Cf. GRI G4: aspect „Training and education“; indicator LA9
21	Companies with advanced training	Share of the companies in the sector which are practicing advanced training, to the total number of companies in the sector	Number of the companies in the sector which are practicing advanced training / Number of companies (in percent)	Cf. GRI G4: Management approach for the aspect „Training and education“
22	Activities to promote diversity and equal opportunities	Activities ot the chemical industry to promote diversity and equal opportunities (agreements between the social partners, allocation of the employees by category: gender, age group and nationality, Altersgruppe und Nationalität)	Number of employees according to diversity criteria	Cf. GRI G4: Management approach for the aspect „Diversity and equal opportunities“
23	Gross value added	Gross value added by enterprises in the sector, in euro	In billion euros, in prices of the respective year	GRI G4: aspect „Economic performance“; indicator EC1
24	Share in the gross value added by German industry	The share of the gross value added by companies in the industry in the total value added by German industry in percent	Gross value added / Total value added of the manufacturing sector (in percent)	--
25	Investments	Investments of the companies of the chemical industry in Germany in euro (property, plant and equipment, environmental protection without R & D)	In billion euros, in prices of the respective year	GRI G4: aspect „Total“; indicator EN31
26	Global market share	Share of the chemical industry in world chemical exports in percent	German chemical exports / World chemical exports (in percent)	--
27	Foreign trade balance	Foreign trade balance of the sector in euro	Exports minus imports (in billion euro, positive or negative)	--

No.	Short name	Indicator	Calculation/Unit	Reference documents
28	Expenditure for research and development	Expenditure of companies in the research and development sector	in million euro	--
29	Newly registered patents	Number of worldwide patents newly registered by companies in the sector	Number of patent applications (absolute)	--
30	Employees in research and development	Number of persons employed in the chemical and pharmaceutical industry in research and development	R&D-employees in fulltime equivalents (FTE)	--
31	Companies with sustainability criteria in innovation and development processes	Share of companies in the sector, which systematically take into account sustainability criteria in innovation and development processes	Number of companies with sustainability criteria in innovation and development processes / Number of answered questionnaires (in percent)	--
32	Companies with management systems for updating or quality assurance of their REACH dossiers	Number of companies that have implemented management systems for updating or quality assurance of their REACH dossiers	Number of companies with management systems for updating or quality assurance of their REACH dossiers / Number of answered questionnaires (in percent)	SASB Chemical Standard: aspect „Safety & Environmental Stewardship of Chemicals & Genetically Modified Organisms“ (Cf. indicator RT0101-10)
33	Published „GPS-Safety Summaries“	Number of published „GPS-Safety-Summaries“	Number of „GPS-Safety-Summaries“	Cf. G4-Guidelines of the Global Reporting Initiative: G4-PR-1
34	Absolute greenhouse gas emissions (Scope 1 and 2)	Absolute greenhouse gas emissions from the chemical-pharmaceutical industry in Germany (Scope 1 and 2)	Energy-related CO_2 emissions (from fuel consumption and purchased electricity) + nitrous oxide (N_2O) (in tonnes of CO_2 equivalents)	GRI G4: aspect „Emissions“; indicatoren EN15, EN16, EN19

No.	Short name	Indicator	Calculation/Unit	Reference documents
35	Greenhouse gas emissions per production unit	Greenhouse gas emissions from the chemical-pharmaceutical industry per product unit (i.e. energy-related CO_2 emissions + nitrous oxide emissions [N_2O] based on the production index, base year 2000 = 100)	Energy-related CO_2 emissions (from fuel consumption and purchased electricity) + nitrous oxide (N_2O) / number of product units (ratio of tonnes of CO_2 equivalents per product unit) Initial value of the product unit: Production index for the chemical-pharmaceutical industry based on the base year 2000 = 100	GRI G4: aspect „Emissions“; indicator EN18
36	Companies that collect Scope 3 greenhouse gas emissions	Share of companies in the sector that capture Scope 3 greenhouse gas emissions for at least one category according to the Greenhouse Gas Protocol	Number of companies that capture Scope 3 greenhouse gas emissions for at least one category / Number of answered questionnaires (in percent)	GRI G4: aspect „Emissionen“; indicator EN17
37	Companies with efficiency targets for raw material use or waste quantities	Share of enterprises with efficiency targets for (specific) raw material input or (specific) waste quantities.	Number of enterprises with efficiency targets for raw material input or waste quantities / Number of answered questionnaires (in percent)	GRI G4: Disclosures on Management Approach (DMA) for the aspects „Materials“ and „Effluents and waste“
38	Specific raw material use in relation to the production index	Specific use of raw materials (use of petrochemical raw materials based on the production index)	Index Use of petrochemical raw materials / production index Initial value: # Use of petrochemical raw materials in tonnes in year X, indexed for the base year 2000 = 100 # Production index in year X relative to the base year 2000 = 100	--
39	Companies that know Chemie[3]	Share of enterprises in the sector, which know the initiative Chemie[3]	Number of companies, which know the initiative Chemie[3] / Number of answered questionnaires (in percent)	--
40	Use of the support offers from	Number of participants from companies of the sector at events of Chemie[3] and use or	Number of participants from companies of the sector at events of	--

No.	Short name	Indicator	Calculation/Unit	Reference documents
	Chemie^3	download of tools on the web-site of Chemie^3.	Chemie^3 and number of use or download of tools on the website of Chemie^3.	

Own compilation, using the following sources: Chemie^3: Fortschrittsindikatoren-Steckbriefe (in German) https://www.chemiehoch3.de/fileadmin/user_upload/Chemie3_Fortschrittsindikatoren_Steckbriefe.pdf

14.4 Annex IV: Global Reporting Initiative: Specific standard disclosures indicators

The adherence level reflects the extent to which the GRI Sustainability Reporting Framework has been applied to a report. For GRI G4 reports there are two options:

- In accordance – Core: At least one indicator related to each identified material aspect has to be reported.
- In accordance – Comprehensive: All indicators related to each identified material aspect have to be reported.

Table 89: Addison[308]: GRI's Specific standard disclosures indicators (no official GRI document)

Aspects	#	Disclosure	Detailed description
	G4-DMA	Disclosures on management approach (DMA)	Narrative information on how an organization identifies, analyzes and responds to its actual and potential material economic, environmental and social impacts. a. Why the aspect is material. Report the impacts that make this aspect material. b. How the organization manages the material aspect or its impacts. c. Evaluation of management approach, including: ► The mechanisms for evaluating the effectiveness of the management approach ► The results of the evaluation of the management approach ► Any related adjustments to the management approach
Category:	**Economic**		
Economic performance	G4-EC1	Economic value	a. Direct economic value generated and distributed (EVG&D) on an accruals basis, including the basic components for the organization's global operations as listed below. If data is presented on a cash basis, report the justification for this decision and report the basic components as listed below: ► Direct economic value generated: ▪ Revenues ► Economic value distributed: ▪ Operating costs ▪ Employee wages and benefits ▪ Payments to providers of capital ▪ Payments to government (by country) ▪ Community investments ► Economic value retained (calculated as 'Direct economic value generated' less 'Economic value distributed') b. To assess local economic impacts better, report EVG&D separately at country, regional, or market levels, where significant. Report the criteria used for defining significance.
	G4-EC2	Climate change risks	Risks and opportunities posed by climate change that have the potential to generate substantive changes in operations, revenue, or expenditure, including: ► A description of the risk or opportunity and its classification as either physical, regulatory or other ► A description of the impact associated with the risk or opportunity ► The financial implications of the risk or opportunity before action is taken ► The methods used to manage the risk or opportunity ► The costs of actions taken to manage the risk or oppor-

[308] http://www.addison.com/wp-content/uploads/2013/11/G4-content-index.xlsx

Aspects	#	Disclosure	Detailed description
			tunity
	G4-EC3	Benefit plan coverage	a. Where the plan's liabilities are met by the organization's general resources, report the estimated value of those liabilities. b. Where a separate fund exists to pay the plan's pension liabilities, report: ► The extent to which the scheme's liabilities are estimated to be covered by the assets that have been set aside to meet them ► The basis on which that estimate has been calculated ► When that estimate was made c. Where a fund set up to pay the plan's pension liabilities is not fully covered, explain the strategy, if any, adopted by the employer to work towards full coverage, and the time scale, if any, by which the employer hopes to achieve full coverage. d. Percentage of salary contributed by employee or employer. e. Level of participation in retirement plans (such as participation in mandatory or voluntary schemes, regional or country-based schemes, or those with financial impact).
Market presence	G4-EC4	Financial assistance from the government	a. Total monetary value of financial assistance received by the organization from governments during the reporting period, including, as a minimum: ► Tax relief and tax credits ► Subsidies ► Investment grants, research and development grants, and other relevant types of grants ► Awards ► Royalty holidays ► Financial assistance from Export Credit Agencies (ECAs) ► Financial incentives ► Other financial benefits received or receivable from any government for any operation b. Information above by country. c. Whether, and the extent to which, the government is present in the shareholding structure.
	G4-EC5	Ratio of entry level wage to local minimum wage	a. When a significant proportion of the workforce is compensated based on wages subject to minimum wage rules, report the ratio of the entry level wage by gender at significant locations of operation to the minimum wage. b. Whether a local minimum wage is absent or variable at significant locations of operation, by gender. In circumstances in which different minimums could be used

Aspects	#	Disclosure	Detailed description
			as a reference, report which minimum wage is being used. c. Definition used for 'significant locations of operation.'
	G4-EC6	Proportion of senior management hired from the local community	a. Percentage of senior management at significant locations of operation that are hired from the local community. b. Definition of 'senior management' used. c. Organization's geographical definition of 'local'. d. Definition used for 'significant locations of operation'.
Indirect economic impacts	G4-EC7	Infrastructure investments	a. Extent of development of significant infrastructure investments and services supported. b. Current or expected impacts on communities and local economies. Report positive and negative impacts, where relevant. c. Whether these investments and services are commercial, in-kind, or pro bono engagements.
	G4-EC8	Indirect economic impacts	a. Examples of the significant identified positive and negative indirect economic impacts the organization has. These may include: ► Changing the productivity of organizations, sectors, or the whole economy ► Economic development in areas of high poverty ► Economic impact of improving or deteriorating social or environmental conditions ► Availability of products and services for those on low incomes ► Enhancing skills and knowledge amongst a professional community or in a geographical region ► Jobs supported in the supply chain or distribution chain ► Stimulating, enabling, or limiting foreign direct investment ► Economic impact of change in location of operations or activities ► Economic impact of the use of products and services b. Significance of the impacts in the context of external benchmarks and stakeholder priorities, such as national and international standards, protocols, and policy agendas.
Procurement practices	G4-EC9	Local suppliers	a. Percentage of the procurement budget used for significant locations of operation spent on suppliers local to that operation (such as percentage of products and services purchased locally). b. Report the organization's geographical definition of 'local'. c. Report the definition used for 'significant locations of operation'.
Category:	**Environm.**		

Aspects	#	Disclosure	Detailed description
Materials	G4-EN1	Materials by weight or volume	Total weight or volume of materials that are used to produce and package the organization's primary products and services during the reporting period, by: ► Non-renewable materials used ► Renewable materials used
	G4-EN2	Recycled input materials	Percentage of recycled input materials used to manufacture the organization's primary products and services.
Energy	G4-EN3	Energy consumption (Scope 1 + 2)	a. Total fuel consumption from non-renewable sources in joules or multiples, including fuel types used. b. Total fuel consumption from renewable fuel sources in joules or multiples, including fuel types used. c. Report in joules, watt-hours or multiples, the total: ► Electricity consumption ► Heating consumption ► Cooling consumption ► Steam consumption d. In joules, watt-hours or multiples, the total: ► Electricity sold ► Heating sold ► Cooling sold ► Steam sold e. Total energy consumption in joules or multiples. f. Standards, methodologies and assumptions used. g. Source of the conversion factors used.
	G4-EN4	Energy consumption (Scope 3)	a. Energy consumed outside the organization, in joules or multiples. b. Standards, methodologies and assumptions used. c. Source of the conversion factors used.
	G4-EN5	Energy intensity	a. Energy intensity ratio. b. Organization-specific metric (the ratio denominator) chosen to calculate the ratio. c. Types of energy included in the intensity ratio: Fuel, electricity, heating, cooling, steam, or all. d. Whether the ratio uses energy consumed within the organization, outside it or both.
	G4-EN6	Energy reductions	a. Amount of reductions in energy consumption achieved as a direct result of conservation and efficiency initiatives, in joules or multiples. b. Types of energy included in the reductions: Fuel, electricity, heating, cooling and steam. c. Basis for calculating reductions in energy consumption such as base year or baseline, and the rationale for choosing it. d. Standards, methodologies and assumptions used.

Aspects	#	Disclosure	Detailed description
	G4-EN7	Energy reductions in products and services	a. Reductions in the energy requirements of sold products and services achieved during the reporting period, in joules or multiples. b. Basis for calculating reductions in energy consumption, such as base year or baseline, and the rationale for choosing it. c. Report standards, methodologies and assumptions used.
Water	G4-EN8	Water withdrawals by source	a. Total volume of water withdrawn from the following sources: ► Surface water, including water from wetlands, rivers, lakes and oceans ► Groundwater ► Rainwater collected directly and stored by the organization ► Waste water from another organization ► Municipal water supplies or other water utilities b. Report standards, methodologies and assumptions used.
	G4-EN9	Water sources affected by withdrawals	a. Total number of water sources significantly affected by withdrawal by type: ► Size of water source ► Whether or not the source is designated as a protected area (nationally or internationally) ► Biodiversity value (such as species diversity and endemism, total number of protected species) ► Value or importance of water source to local communities and indigenous peoples b. Standards, methodologies and assumptions used.
	G4-EN10	Water recycled and reused	a. Total volume of water recycled and reused by the organization. b. Total volume of water recycled and reused as a percentage of the total water withdrawal reported under Indicator G4-EN8. c. Standards, methodologies and assumptions used.
Bio-diversity	G4-EN11	Facilities in or near areas of high diversity	Information for each operational site owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas: ► Geographic location ► Subsurface and underground land that may be owned, leased or managed by the organization ► Position in relation to the protected area (in the area, adjacent to, or containing portions of the protected area) or the high biodiversity value area outside protected areas ► Type of operation (office, manufacturing/production or extractive) ► Size of operational site in km^2 ► Biodiversity value characterized by: ▪ The attribute of the protected area or high biodiversity value area outside the protected area (terrestrial, freshwater or maritime ecosystem) ▪ Listing of protected status (such as IUCN Protected

Aspects	#	Disclosure	Detailed description
			Area Management Categories, Ramsar Convention, national legislation)
	G4-EN12	Impacts on biodiversity	a. Nature of significant direct and indirect impacts on biodiversity with reference to one or more of the following: ► Construction or use of manufacturing plants, mines and transport infrastructure ► Pollution (introduction of substances that do not naturally occur in the habitat from point and non-point sources) ► Introduction of invasive species, pests and pathogens ► Reduction of species ► Habitat conversion ► Changes in ecological processes outside the natural range of variation (such as salinity or changes in groundwater level) b. Significant direct and indirect positive and negative impacts with reference to the following: ► Species affected ► Extent of areas impacted ► Duration of impacts ► Reversibility or irreversibility of the impacts
	G4-EN13	Habitats protected or restored	a. Size and location of all habitat protected areas or restored areas and whether the success of the restoration measure was or is approved by independent external professionals. b. Whether partnerships exist with third parties to protect or restore habitat areas distinct from where the organization has overseen and implemented restoration or protection measures. c. Status of each area based on its condition at the close of the reporting period. d. Standards, methodologies and assumptions used.
	G4-EN14	IUCN Red List species	Total number of IUCN Red List species and national conservation list species with habitats in areas affected by the operations of the organization, by level of extinction risk: ► Critically endangered ► Endangered ► Vulnerable ► Near threatened

Aspects	#	Disclosure	Detailed description
			► Least concern
Emissions	G4-EN15	GHG emissions (Scope 1)	a. Gross direct (Scope 1) GHG emissions in metric tons of CO_2 equivalent, independent of any GHG trades, such as purchases, sales or transfers of offsets or allowances. b. Gases included in the calculation (whether CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3, or all). c. Biogenic CO_2 emissions in metric tons of CO_2 equivalent separately from the gross direct (Scope 1) GHG emissions. d. Chosen base year, the rationale for choosing the base year, emissions in the base year and the context for any significant changes in emissions that triggered recalculations of base year emissions. e. Standards, methodologies and assumptions used. f. Source of the emission factors used and the global warming potential (GWP) rates used or a reference to the GWP source. g. Chosen consolidation approach for emissions (equity share, financial control, operational control).
	G4-EN16	GHG emissions (Scope 2)	a. Gross energy indirect (Scope 2) GHG emissions in metric tons of CO_2 equivalent, independent of any GHG trades, such as purchases, sales or transfers of offsets or allowances. b. Gases included in the calculation, if available. c. Chosen base year, the rationale for choosing the base year, emissions in the base year and the context for any significant changes in emissions that triggered recalculations of base year emissions. d. Standards, methodologies and assumptions used. e. Source of the emission factors used and the global warming potential (GWP) rates used or a reference to the GWP source, if available. f. Chosen consolidation approach for emissions (equity share, financial control, operational control).
	G4-EN17	GHG emissions (Scope 3)	a. Gross other indirect (Scope 3) GHG emissions in metric tons of CO_2 equivalent, excluding indirect emissions from the generation of purchased or acquired electricity, heating, cooling and steam consumed by the organization (these indirect emissions are reported in Indicator G4-EN16). Exclude any GHG trades, such as purchases, sales or transfers of offsets or allowances. b. Gases included in the calculation, if available. c. Biogenic CO_2 emissions in metric tons of CO_2 equivalent separately from the gross other indirect (Scope 3) GHG

Aspects	#	Disclosure	Detailed description
			emissions. d. Other indirect (Scope 3) emissions categories and activities included in the calculation. e. Chosen base year, the rationale for choosing the base year, emissions in the base year and the context for any significant changes in emissions that triggered recalculations of base year emissions. f. Standards, methodologies and assumptions used. g. Source of the emission factors used and the global warming potential (GWP) rates used or a reference to the GWP source, if available.
	G4-EN18	GHG emissions intensity	a. GHG emissions intensity ratio. b. Organization-specific metric (the ratio denominator) chosen to calculate the ratio. c. Types of GHG emissions included in the intensity ratio: Direct (Scope 1), energy indirect (Scope 2), other indirect (Scope 3). d. Gases included in the calculation.
	G4-EN19	Reduction of GHG emissions	a. Amount of GHG emissions reductions achieved as a direct result of initiatives to reduce emissions, in metric tons of CO_2 equivalent. b. Gases included in the calculation (whether CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3, or all). c. Chosen base year or baseline and the rationale for choosing it. d. Standards, methodologies and assumptions used. e. Whether the reductions in GHG emissions occurred in direct (Scope 1), energy indirect (Scope 2) or other indirect (Scope 3) emissions.
	G4-EN20	Ozone-depleting substances (ODS)	a. Production, imports, and exports of ODS in metric tons of CFC-11 equivalent. b. Substances included in the calculation. c. Standards, methodologies and assumptions used. d. Source of the emission factors used.
	G4-EN21	NO_x, SO_x and other emissions	a. Amount of significant air emissions, in kilograms or multiples for each of the following: ► NO_x ► SO_x ► Persistent organic pollutants (POP) ► Volatile organic compounds (VOC) ► Hazardous air pollutants (HAP) ► Particulate matter (PM) ► Other standard categories of air emissions identified in relevant regulations b. Standards, methodologies and assumptions used. c. Source of the emission factors used.

Aspects	#	Disclosure	Detailed description
Effluents & waste	G4-EN22	Water discharge	a. Total volume of planned and unplanned water discharges by: ► Destination ► Quality of the water including treatment method ► Whether it was reused by another organization b. Standards, methodologies and assumptions used.
	G4-EN23	Waste by type and disposal method	a. Total weight of hazardous and non-hazardous waste, by the following disposal methods: ► Reuse ► Recycling ► Composting ► Recovery, including energy recovery ► Incineration (mass burn) ► Deep well injection ► Landfill ► On-site storage ► Other (to be specified by the organization) b. How the waste disposal method has been determined: ► Disposed of directly by the organization or otherwise directly confirmed ► Information provided by the waste disposal contractor ► Organizational defaults of the waste disposal contractor
	G4-EN24	Significant spills	a. Total number and total volume of recorded significant spills. b. For spills that were reported in the organization's financial statements, report the additional following information for each such spill: ► Location of spill ► Volume of spill ► Material of spill, categorized by: ▪ Oil spills (soil or water surfaces) ▪ Fuel spills (soil or water surfaces) ▪ Spills of wastes (soil or water surfaces) ▪ Spills of chemicals (mostly soil or water surfaces) ▪ Other (to be specified by the organization) c. Impacts of significant spills.
	G4-EN25	Hazardous waste	a. Total weight for each of the following: ► Hazardous waste transported ► Hazardous waste imported ► Hazardous waste exported ► Hazardous waste treated b. Percentage of hazardous waste shipped internationally.
	G4-EN26	Biodiversity affected by runoff	Water bodies and related habitats that are significantly affected by water discharges based on the criteria described in the compilation section below, adding information on: ► Size of water body and related habitat ► Whether the water body and related habitat is designated as a protected area (nationally or internationally) ► Biodiversity value (such as total number of protected

Aspects	#	Disclosure	Detailed description
			species)
Products & services	G4-EN27	Mitigation of environmental impacts of products and services	a. Quantitatively the extent to which environmental impacts of products and services have been mitigated during the reporting period. b. If use-oriented figures are employed, report the underlying assumptions regarding consumption patterns or normalization factors.
	G4-EN28	Products and packaging materials reclaimed	a. Percentage of reclaimed products and their packaging materials for each product category. b. How the data for this indicator has been collected.
Compliance	G4-EN29	Environmental fines and sanctions	a. Significant fines and non-monetary sanctions in terms of: ► Total monetary value of significant fines ► Total number of non-monetary sanctions ► Cases brought through dispute resolution mechanisms b. Where organizations have not identified any non-compliance with laws or regulations, a brief statement of this fact is sufficient.
Transport	G4-EN30	Environmental impacts from product distribution and employee travel	a. Significant environmental impacts of transporting products and other goods and materials for the organization's operations, and transporting members of the workforce. Where quantitative data is not provided, report the reason. b. How the environmental impacts of transporting products, members of the organization's workforce, and other goods and materials are mitigated. c. Criteria and methodology used to determine which environmental impacts are significant.
Environmental investments	G4-EN31	Environmental investments	Total environmental protection expenditures by: ► Waste disposal, emissions treatment and remediation costs ► Prevention and environmental management costs
Supplier Environmental	G4-EN32	New suppliers screened using environmtl. criteria	Percentage of new suppliers that were screened using environmental criteria.
	G4-EN33	Supply chain environmental impacts	a. Number of suppliers subject to environmental impact assessments. b. Number of suppliers identified as having significant actual and potential negative environmental impacts. c. Significant actual and potential negative environmental impacts identified in the supply chain. d. Percentage of suppliers identified as having significant actual and potential negative environmental impacts with which improvements were agreed upon as a result of

Aspects	#	Disclosure	Detailed description
			assessment. e. Percentage of suppliers identified as having significant actual and potential negative environmental impacts with which relationships were terminated as a result of assessment, and why.
Environ-mental grievance mecha-nisms	G4-EN34	Environ-mental grievances	a. Total number of grievances about environmental impacts filed through formal grievance mechanisms during the reporting period. b. Of the identified grievances, report how many were: ► Addressed during the reporting period ► Resolved during the reporting period c. Total number of grievances about environmental impacts filed prior to the reporting period that were resolved during the reporting period.
Category:	**Social**	**Sub-category:**	**Labour Practices & Decent Work**
Employme nt	G4-LA1	Number and rate of new employee hires and turnover	a. Total number and rate of new employee hires during the reporting period, by age group, gender and region. b. Total number and rate of employee turnover during the reporting period, by age group, gender and region.
	G4-LA2	Benefits provided to full-time employees	a. Benefits which are standard for full-time employees of the organization but are not provided to temporary or part-time employees, by significant locations of operation. These include, as a minimum: ► Life insurance ► Health care ► Disability and invalidity coverage ► Parental leave ► Retirement provision ► Stock ownership ► Others b. Definition used for 'significant locations of operation'.
	G4-LA3	Return to work and retention rates after parental leave	a. Total number of employees that were entitled to parental leave, by gender. b. Total number of employees that took parental leave, by gender. c. Total number of employees who returned to work after parental leave ended, by gender. d. Total number of employees who returned to work after parental leave ended who were still employed twelve months after their return to work, by gender. e. Return to work and retention rates of employees who took parental leave, by gender.

Aspects	#	Disclosure	Detailed description
Labour/ manage-ment relations	G4-LA4	Notice periods regarding operational changes	a. Minimum number of weeks' notice typically provided to employees and their elected representatives prior to the implementation of significant operational changes that could substantially affect them. b. For organizations with collective bargaining agreements, report whether the notice period and provisions for consultation and negotiation are specified in collective agreements.
Occupatio nal health & safety	G4-LA5	Workforce represented in health and safety committees	a. Level at which each formal joint management-worker health and safety committee typically operates within the organization. b. Percentage of the total workforce represented in formal joint management-worker health and safety committees.
	G4-LA6	Rates of injury, occupational disease, lost days, absenteeism, and work-related fatalities	a. Types of injury, injury rate (IR), occupational diseases rate (ODR), lost day rate (LDR), absentee rate (AR), and work-related fatalities for the total workforce (that is, total employees plus supervised workers), by: ► Region ► Gender b. Types of injury, injury rate (IR), occupational diseases rate (ODR), lost day rate (LDR), absentee rate (AR), and work-related fatalities for independent contractors working on-site to whom the organization is liable for the general safety of the working environment, by: ► Region ► Gender c. System of rules applied in recording and reporting accident statistics.
	G4-LA7	Workers with high incidence risk of diseases	Whether there are workers who are involved in occupational activities who have a high incidence or high risk of specific diseases.
	G4-LA8	Health and safety topics covered in agreements with trade unions	a. Whether formal agreements (either local or global) with trade unions cover health and safety. b. If yes, report the extent, as a percentage, to which various health and safety topics are covered by these agreements.
Training & education	G4-LA9	Average hours of training for employees	Average hours of training that the organization's employees have undertaken during the reporting period, by: ► Gender ► Employee category
	G4-LA10	Programs for skills management managing career endings	a. Type and scope of programmes implemented and assistance provided to upgrade employee skills. b. Transition assistance programmes provided to facilitate continued employability and the management of career endings resulting from retirement or termination of employment.

Aspects	#	Disclosure	Detailed description
	G4-LA11	Employees receiving performance and career development reviews	Percentage of total employees by gender and by employee category who received a regular performance and career development review during the reporting period.
Diversity	G4-LA12	Composition of governance bodies and employees	a. Percentage of individuals within the organization's governance bodies in each of the following diversity categories: ► Gender ► Age group: Under 30 years old, 30–50 years old, over 50 years old ► Minority groups ► Other indicators of diversity, where relevant b. Percentage of employees per employee category in each of the following diversity categories: ► Gender ► Age group: Under 30 years old, 30–50 years old, over 50 years old ► Minority groups ► Other indicators of diversity, where relevant
Equal pay for women & men	G4-LA13	Ratio of basic salary and remuneration of women to men	a. Ratio of the basic salary and remuneration of women to men for each employee category, by significant locations of operation. b. b. Definition used for 'significant locations of operation'.
Supplier assessment for labour practices	G4-LA14	New suppliers that were screened using labour practices criteria	Percentage of new suppliers that were screened using labour practices criteria.
	G4-LA15	Negative impacts for labour practices in the supply chain	a. Number of suppliers subject to impact assessments for labour practices. b. Number of suppliers identified as having significant actual and potential negative impacts for labour practices. c. Significant actual and potential negative impacts for labour practices identified in the supply chain. d. Percentage of suppliers identified as having significant actual and potential negative impacts for labour practices with which improvements were agreed upon as a result of assessment. e. Percentage of suppliers identified as having significant actual and potential negative impacts for labour practices with which relationships were terminated as a result of assessment, and why.
Labour practices grievance	G4-LA16	Grievances about labour practices	a. a. Total number of grievances about labour practices filed through formal grievance mechanisms during the reporting period.

Aspects	#	Disclosure	Detailed description
mechanisms			b. Of the identified grievances, report how many were: ► Addressed during the reporting period ► Resolved during the reporting period c. Total number of grievances about labour practices filed prior to the reporting period that were resolved during the reporting period.
Category:	**Social**	**Sub-category:**	**Human Rights**
Human rights investments	G4-HR1	Investment agreements and contracts that include human rights clauses or underwent screening	a. Total number and percentage of significant investment agreements and contracts that include human rights clauses or that underwent human rights screening. b. Definition of 'significant investment agreements' used by the organization.
	G4-HR2	Employee training on human rights	a. Total number of hours in the reporting period devoted to training on human rights policies or procedures concerning aspects of human rights that are relevant to operations. b. Percentage of employees in the reporting period trained in human rights policies or procedures concerning aspects of human rights that are relevant to operations.
Non-discrimination	G4-HR3	Incidents of discrimination	a. Total number of incidents of discrimination during the reporting period. b. Status of the incidents and the actions taken with reference to the following: ► Incident reviewed by the organization ► Remediation plans implemented ► Remediation plans have been implemented and results reviewed through routine internal management review processes ► Incident no longer subject to action
Freedom of association	G4-HR4	Significant risk of freedom of association in operations and suppliers	a. Operations and suppliers in which employee rights to exercise freedom of association or collective bargaining may be violated or at significant risk either in terms of: ► Type of operation (such as manufacturing plant) and supplier ► Countries or geographical areas with operations and suppliers considered at risk b. Measures taken by the organization in the reporting period intended to support rights to exercise freedom of association and collective bargaining.
Child labour	G4-HR5	Significant risk of child labour in operations and suppliers	a. Operations and suppliers considered to have significant risk for incidents of: ► Child labour ► Young workers exposed to hazardous work b. Operations and suppliers considered to have significant risk for incidents of child labour either in terms of: ► Type of operation (such as manufacturing plant) and supplier

Aspects	#	Disclosure	Detailed description
			► Countries or geographical areas with operations and suppliers considered at risk c. Measures taken by the organization in the reporting period intended to contribute to the effective abolition of child labour.
Forced or compulsory labour	G4-HR6	Significant risk of forced or compulsory labour in operations and suppliers	a. Operations and suppliers considered to have significant risk for incidents of forced or compulsory labour either in terms of: ► Type of operation (such as manufacturing plant) and supplier ► Countries or geographical areas with operations and suppliers considered at risk b. Measures taken by the organization in the reporting period intended to contribute to the elimination of all forms of forced or compulsory labour.
Security practices	G4-HR7	Security personnel trained in the organization's human rights policies	a. Percentage of security personnel who have received formal training in the organization's human rights policies or specific procedures and their application to security. b. Whether training requirements also apply to third-party organizations providing security personnel.
Indigenous rights	G4-HR8	Incidents of violations involving rights of indigenous peoples	a. Total number of identified incidents of violations involving the rights of indigenous peoples during the reporting period. b. Status of the incidents and actions taken with reference to: ► Incident reviewed by the organization ► Remediation plans implemented ► Remediation plans have been implemented and results reviewed through routine internal management review processes ► Incident no longer subject to action
Human rights assessments	G4-HR9	Operations that have been subject to human rights assessments	Total number and percentage of operations that have been subject to human rights reviews or human rights impact assessments, by country.

Aspects	#	Disclosure	Detailed description
Supplier human rights assess-ments	G4-HR10	New suppliers screened for human rights	Percentage of new suppliers that were screened using human rights criteria.
	G4-HR11	Human rights impacts in the supply chain	a. Number of suppliers subject to human rights impact assessments. b. Number of suppliers identified as having significant actual and potential negative human rights impacts. c. Significant actual and potential negative human rights impacts identified in the supply chain. d. Percentage of suppliers identified as having significant actual and potential negative human rights impacts with which improvements were agreed upon as a result of assessment. e. Percentage of suppliers identified as having significant actual and potential negative human rights impacts with which relationships were terminated as a result of assessment, and why.
Human rights grievance mecha-nisms	G4-HR12	Grievances about human rights impacts	a. Total number of grievances about human rights impacts filed through formal grievance mechanisms during the reporting period. b. Of the identified grievances, report how many were: ► Addressed during the reporting period ► Resolved during the reporting period c. Total number of grievances about human rights impacts filed prior to the reporting period that were resolved during the reporting period.
Category:	**Social**	**Sub-category:**	**Society**
Local commu-nities	G4-SO1	Local community engagement, impact assessments and development programmes	Percentage of operations with implemented local community engagement, impact assessments and development programmes, including the use of: ► Social impact assessments, including gender impact as-sessments, based on participatory processes ► Environmental impact assessments and ongoing monitor-ing ► Public disclosure of results of environmental and social impact assessments ► Local community development programmes based on lo-cal communities' needs ► Stakeholder engagement plans based on stakeholder mapping ► Broad-based local community consultation committees and processes that include vulnerable groups ► Works councils, occupational health and safety commit-tees and other employee representation bodies to deal with impacts ► Formal local community grievance processes
	G4-SO2	Negative impacts on local	Operations with significant actual and potential negative impacts on local communities, including: ► The location of the operations

Aspects	#	Disclosure	Detailed description
		communities	► The significant actual and potential negative impacts of operations
Anti-corruption	G4-SO3	Risks related to corruption	a. Total number and percentage of operations assessed for risks related to corruption. b. Significant risks related to corruption identified through the risk assessment.
	G4-SO4	Communications and training on anti-corruption	a. a. Total number and percentage of governance body members to which the organization's anti-corruption policies and procedures have been communicated, broken down by region. b. Total number and percentage of employees to which the organization's anti-corruption policies and procedures have been communicated, broken down by employee category and region. c. Total number and percentage of business partners to which the organization's anti-corruption policies and procedures have been communicated, broken down by type of business partner and region. d. Total number and percentage of governance body members that have received training on anti-corruption, broken down by region. e. Total number and percentage of employees that have received training on anti-corruption, broken down by employee category and region.
	G4-SO5	Confirmed incidents of corruption	a. Total number and nature of confirmed incidents of corruption. b. Total number of confirmed incidents in which employees were dismissed or disciplined for corruption. c. Total number of confirmed incidents when contracts with business partners were terminated or not renewed due to violations related to corruption. d. Public legal cases regarding corruption brought against the organization or its employees during the reporting period and the outcomes of such cases.
Public policy	G4-SO6	Political contributions	a. a. Total monetary value of financial and in-kind political contributions made directly and indirectly by the organization by country and recipient/beneficiary. b. How the monetary value of in-kind contributions was estimated, if applicable.
Anti-competitive behaviour	G4-SO7	Anti-competitive behaviour	a. Total number of legal actions pending or completed during the reporting period regarding anti-competitive behaviour and violations of anti-trust and monopoly legislation in which the organization has been identified as a participant. b. Main outcomes of completed legal actions, including any decisions or judgements.

Aspects	#	Disclosure	Detailed description
Com-pliance	G4-SO8	Fines for non-compliance with laws	a. Significant fines and non-monetary sanctions in terms of: ► Total monetary value of significant fines ► Total number of non-monetary sanctions ► Cases brought through dispute resolution mechanisms b. If the organization has not identified any non-compliance with laws or regulations, a brief statement of this fact is sufficient. c. Context against which significant fines and non-monetary sanctions were incurred.
Supplier assess-ment for impacts on society	G4-SO9	New suppliers screened for impacts on society	Percentage of new suppliers that were screened using criteria for impacts on society.
	G4-SO10	Negative impacts on society in the supply chain	a. Number of suppliers subject to assessments for impacts on society. b. Number of suppliers identified as having significant actual and potential negative impacts on society. c. Significant actual and potential negative impacts on society identified in the supply chain. d. Percentage of suppliers identified as having significant actual and potential negative impacts on society with which improvements were agreed upon as a result of assessment. e. Percentage of suppliers identified as having significant actual and potential negative impacts on society with which relationships were terminated as a result of assessment, and why.
Grievance mecha-nisms for impacts on society	G4-SO11	Grievances about impacts on society	a. Total number of grievances about impacts on society filed through formal grievance mechanisms during the reporting period. b. Of the identified grievances, report how many were: ► Addressed during the reporting period ► Resolved during the reporting period c. Total number of grievances about impacts on society filed prior to the reporting period that were resolved during the reporting period.

Aspects	#	Disclosure	Detailed description
Category:	**Social**	**Sub-category:**	**Product Responsibility**
Customer health & safety	G4-PR1	Health and safety impact assessments of products and services	Percentage of significant product and service categories for which health and safety impacts are assessed for improvement.
	G4-PR2	Non-compliance concerning the health and safety impacts of products and services	a. Total number of incidents of non-compliance with regulations and voluntary codes concerning the health and safety impacts of products and services within the reporting period, by: ► Incidents of non-compliance with regulations resulting in a fine or penalty ► Incidents of non-compliance with regulations resulting in a warning ► Incidents of non-compliance with voluntary codes b. If the organization has not identified any non-compliance with regulations and voluntary codes, a brief statement of this fact is sufficient.
Product & service labelling	G4-PR3	Product and service information required for labelling	a. Whether the following product and service information is required by the organization's procedures for product and service information and labelling (YES/NO): ► The sourcing of components of the product or service ► Content, particularly with regard to substances that might produce an environmental or social impact ► Safe use of the product or service ► Disposal of the product and environmental/social impacts ► Other (explain) b. Percentage of significant product or service categories covered by and assessed for compliance with such procedures.
	G4-PR4	Non-compliance with regulations concerning product and service labelling	a. Total number of incidents of non-compliance with regulations and voluntary codes concerning product and service information and labelling, by: ► Incidents of non-compliance with regulations resulting in a fine or penalty ► Incidents of non-compliance with regulations resulting in a warning ► Incidents of non-compliance with voluntary codes b. If the organization has not identified any non-compliance with regulations and voluntary codes, a brief statement of this fact is sufficient.
	G4-PR5	Surveys measuring customer satisfaction	Results or key conclusions of customer satisfaction surveys (based on statistically relevant sample sizes) conducted in the reporting period relating to information about: ► The organization as a whole ► A major product or service category ► Significant locations of operation

Aspects	#	Disclosure	Detailed description
Marketing & communications	G4-PR6	Sale of banned or disputed products	a. Whether the organization sells products that are: ► Banned in certain markets ► The subject of stakeholder questions or public debate b. How the organization has responded to questions or concerns regarding these products.
	G4-PR7	Non-compliance with regulations concerning marketing communications	a. Total number of incidents of non-compliance with regulations and voluntary codes concerning marketing communications, including advertising, promotion and sponsorship, by: ► Incidents of non-compliance with regulations resulting in a fine or penalty ► Incidents of non-compliance with regulations resulting in a warning ► Incidents of non-compliance with voluntary codes b. If the organization has not identified any non-compliance with regulations and voluntary codes, a brief statement of this fact is sufficient.
Customer privacy	G4-PR8	Complaints regarding breaches of customer privacy and losses of customer data	a. Total number of substantiated complaints received concerning breaches of customer privacy, categorized by: ► Complaints received from outside parties and substantiated by the organization ► Complaints from regulatory bodies b. Total number of identified leaks, thefts or losses of customer data. c. If the organization has not identified any substantiated complaints, a brief statement of this fact is sufficient.
Product compliance	G4-PR9	Fines for non-compliance with laws and regulations concerning products and services	a. Total monetary value of significant fines for non-compliance with laws and regulations concerning the provision and use of products and services. b. If the organization has not identified any non-compliance with laws or regulations, a brief statement of this fact is sufficient.

Own compilation, using the following source:
http://www.addison.com/wp-content/uploads/2013/11/G4-content-index.xlsx

14.5 Annex V: Chemical companies with GRI reports in accordance with GRI-G4, published 2015/16 (as of the end of August 2016)

14.5.1 Africa

As of the end of August 2016, the GRI database listed only three GRI (stand-alone or integrated) reports or references, published in 2015 or later by companies in the chemical sector in Africa, but none of them were in accordance with G4.

Table 90: Selected African chemical companies with sustainability/CSR reports in accordance with GRI, published in 2015/16 (non-exhaustive list, based on http://database.globalreporting.org)

Country	Company: Report (2015/16)	GRI
South Africa	AECI: Integrated Report 2014	Non – GRI, integrated
	AFROX (African Oxygen Limited): Integrated Report 2014	G3 undeclared [a)], integrated
	Omnia Holdings: Integrated annual report 2015	G3.1 C self-declared, integrated

a) There is no explicit 'in accordance' option declared, but the report contains a complete G3 Content Index.

14.5.2 Asia

As of the end of August 2016, the GRI database listed about 80 GRI (stand-alone or integrated) reports or references in accordance with G4, published in 2015 or later by companies in the chemical sector in Asia. Over 50 of them were by companies from Taiwan.

Table 91: Selected Asian chemical companies with sustainability/CSR reports in accordance with GRI G4 in 2015/16 (non-exhaustive list; in the case of annual reporting only the latest report is cited)

Country	Company: Report (2015/16)	GRI G4
India	Enpro Industries Private Limited: Corporate Sustainability Report 2014-15	Core
	L.N. CHEMICAL INDUSTRIES: Sustainability Report 2014-15	Core
Indonesia	PT Pupuk Kujang: Sustainable Innovation for Food Security 2014	Core
Israel	Israel Chemicals Ltd (ICL): Israel Chemicals Ltd. Corporate Responsibility Report 2014	Core
Japan	Asahi Glass Company: AGC Report 2015	Core
	Denka (Denki Kagaku Kogyo): CSR Report 2015	Undeclared [a)]
	Hitachi Chemical: Annual Report 2015	Undeclared [a)]
	JSR Corp.: CSR Report 2015	Undeclared [a)]
	Kao Corporation: Sustainability Report 2015	Undeclared [a)]
	Mitsui Chemicals: CSR Report 2015	Core
	NGK Insulators: CSR Report 2015	Undeclared [a)]
	Sekisui Chemical: CSR Report 2015	Undeclared [a)]
	Showa Denko: CSR Report 2015	Undeclared [a)]

Country	Company: Report (2015/16)	GRI G4
	Sumitomo Chemicals: CSR Report 2015	Undeclared [a)]
	tok: CSR Report 2015	Undeclared [a)]
Korea, Republic of	LG Chem: 2014 LG Chem Sustainability Report	Core
	LOTTE CHEMICAL: 2014 Sustainability Report	Core
	SK Chemicals: Sustainability Report 2014	Core
Kuwait	Equate: Sustainability Report 2014 Making the Impossible Possible	Core
	Petrochemical Industries Company (K.S.C): Sustainable Tomorrow. Sustainable Journey	Core
Pakistan	Fauji Fertilizer Company (FFC): 2014 Sustainability Report "Endeavor"	Comprehensive
Qatar	Q-Chem: Sustainability Report 2014	Core
	QAFCO: CSR Report 2014	Core
	QAPCO: REALIZING VALUE. QAPCO 2014 Integrated Report	Core, Integrated
	Qatar Fuel Additives Company (QAFAC): Adding Value Beyond Expectations. QAFAC 2014 Sustainability Report	Core
Taiwan	Advanced Lithium Electrochemistry (KY): 2014 Aleees Corporate Sustainability Report	Core
	ALLIED INDUSTRIAL CORP., LTD.: 2014 Corporate Social Responsibility Report (Chinese Version)	Undeclared [a)]
	ASIA POLYMER CORPORATION: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	CATHAY CHEMICAL WORKS INC (CCW): 2014-CSR-Report	Core
	CHINA GENERAL PLASTICS CORPORATION: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	China Man-Made Fiber Corporation: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	China Petrochemical Development Corporation(CPDC): 2014 Sustainability Report	Core
	China Steel Chemical Corp. (CSCC): 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	CHUNG HWA CHEMICAL INDUSTRIAL WORKS, LTD.,: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	Coremax Corporation (COREMAX): 2014 Corporate Sustainability Report	Core
	DAILY POLYMER CORP.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	ETERNAL: 2014 Corporate Social Responsibility Report (Chinese Version)	Undeclared [a)]
	Everlight Chemical: 2014 CSR Report	Undeclared [a)]
	EVERMORE CHEMICAL INDUSTRY CO., LTD.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	Far Eastern New Century (FENC): 2013-2014 Corporate Social Responsibility Report	Comprehensive
	FARCENT ENTERPRISE CO., LTD: 2014 Corporate Social	Core

Country	Company: Report (2015/16)	GRI G4
	Responsibility Report (Chinese Version)	
	FORMOSA CHEMICALS & FIBRE CORPORATION: 2014 CSR Report (Chinese Version)	Core
	Formosa Plastics Corporation: 2014 CSR Report	Core
	FORMOSAN UNION CHEMICAL CORP (FUCC): 2014 Sustainability Report	Core
	GRAND PACIFIC PETROCHEMICAL CORPORATION: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	HO TUNG CHEMICAL CORP.: 2014 Sustainability Report (Chinese Version)	Core
	JINTEX CORPORATION LTD.: 2015 Corporate Sustainability Report (Chinese Version)	Core
	LCYCIC: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	Mao Bao INC.: 2014 Corporate Social Responsibility (Chinese Version)	Core
	MECHEMA CHEMICALS INT CORP.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	NAN YA PLASTICS CORPORATION: 2014 CSR Report (Chinese Version)	Core
	ORIENTAL UNION CHEMICAL CORP (OUCC): 2014 CSR Report	Core
	PAN ASIA CHEMICAL (PACC): Corporate Social Responsibility Report	Core
	QUALIPOLY CHEMICAL CORP (QPC): CSR Report 2014	Core
	San Fu Chemical Co., Ltd.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	SESODA: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	SHINKONG SYNTHETIC FIBER: 2014 Corporate Social Responsibility Report (Chinese Version)	Comprehensive
	Shiny Chemical Industrial Co., Ltd: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	Shuang-Bang Industrial Corp.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	SINON CORPORATION: 2014 Corporate Social Responsibility Report (Chinese Version)	Undeclared [a)]
	Standard Chemical & Pharmaceutical Co. Ltd.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	SUN YAD TECHNOLOGY CO., LTD: 2014 Corporate Social Responsibility Report (Chinese Version)	Undeclared [a)]
	SUNKO INK CO., LTD: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	SWANCOR IND. CO., LTD.: 2014 Corporate Sustainability Report	Core, Integrated
	T.N.C. Industrial Co., Ltd: Corporate Social Responsibility Report 2014	Core

Country	Company: Report (2015/16)	GRI G4
	TAITA CHEMICAL COMPANY, LIMITED: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	TAIWAN FERTILIZER CO., LTD.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	TAIWAN HOPAX Chemicals: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	Taiwan Prosperity Chemical Corporation: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	TAIWAN WAX COMPANY, LTD.: 2014 Corporate Social Responsibility Report (Chinese Version)	Undeclared a)
	TEX YEAR INDUSTRIES INC. (TEX YEAR): 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	U-BEST POLYMER INDUSTRY CO (UB): 2014 Corporate Social Responsibility Report (Chinese Version)	Undeclared a)
	UPC TECHNOLOGY CORPORATION: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	USI CORPORATION: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	YONG SHUN CHEMICAL CO., LTD (YONG SHUN): Corporate Social Responsibility Report 2014	Core
	YUAN JEN ENTERPRISES CO., LTD.: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
	YUNG CHI PAINT & VARNISH MFG. CO., LTD: 2014 Corporate Social Responsibility Report (Chinese Version)	Core
Thailand	Indorama Ventures Public Company Limited: Indorama Ventures – 2014 Sustainability Report	Core
	PTT Global Chemical Public Company Limited: PTTGC Sustainability Report 2014	Core
United Arab Emirates	Abu Dhabi Polymers Company (Borouge): Sustainability Report 2014	Core

a) There is no explicit 'in accordance' option declared, but the report contains a complete G4 Content Index.

Source: Own compilation, mainly based on http://database.globalreporting.org

14.5.3 Europe

As of the end of August 2016, the GRI database listed 27 GRI (stand-alone or integrated) reports or references in accordance with G4, published in 2015 or later by companies in the chemical sector in Europe. Some current reports have not been listed yet, but were available on the websites of the respective companies.

Table 92: Selected European chemical companies with sustainability/CSR reports in accordance with GRI G4 in 2015/16 (non-exhaustive list; in the case of annual reporting only the latest report is cited)

Country	Company: Report (2015/16)	GRI G4
Belgium	SOLVAY s.a.: 2015 Complementary annual report on Sustainable Development informations	Core
	JSR Micro NV: 2015 CSR Report	Core
Finland	Kemira: Corporate Responsibility Report 2015	Core, integrated
	Kiilto: Vastuullisia tekoja sidosryhmien hyvaksi	Core
France	Adisseo France SAS: Sustainable Development Report 2015	Undeclared [a)]
Germany	BASF SE: BASF Report 2015	Comprehensive, integrated
	Bayer AG: Annual Report 2015	Comprehensive, integrated
	Biesterfeld AG: Sustainability Report Biesterfeld AG – 2014	Core
	Brenntag AG: Connecting Chemistry. Nachhaltigkeitsbericht 2016	Core
	Evonik Industries: Perspective Change.	Core
	LANXESS AG: Annual Report 2015	Core
	Messer Group GmbH: Our way. Corporate Responsibility Report and Management Report 2015	Core
	Symrise AG: Nachhaltigkeitsbilanz 2014	Comprehensive
	The Linde Group: CR Report 2015 [b)]	Comprehensive, integrated
Italy	Novamont: Rapporto di Sostenibilità 2014: uno strumento di rendicontazione e strategia	Core
Netherlands	AkzoNobel NV: AkzoNobel Report 2015	Core, integrated
	Core Lab: CORPORATE RESPONSIBILITY 2014	Undeclared [a)]
	DSM: 2014 Integrated Annual Report	Comprehensive, integrated
	Royal Dutch Shell plc: Sustainability Report 2015 [b)]	Core
Norway	Kemira Chemicals AS: Corporate Responsibility Report 2014	Core
Portugal	CUF – Companhia União Fabril: CUF Sustainability Report 2015	Core
Russia	Eurochem: EuroChem Sustainability Report 2014	Core
	Kazanorgsintez: Sustainable Development Report 2014	Core
	OJSC Nizhnekamskneftekhim: Sustainability Report 2015	Core
	Sanofi Group Russia: CSR Report 2013-2014	Core
	Uralkali: Integrated Report 2014	Core, integrated
Sweden	HEXPOL: Sustainability Report 2014	Core
Switzerland	Clariant: Clariant Sustainability Report 2015	Core
	Firmenich: Performance and Sustainability Report 2015	Core

Country	Company: Report (2015/16)	GRI G4
	Givaudan International SA: Sustainability Report 2015	Core
	Sika AG: Annual Report 2014	Core
United Kingdom	Croda: Sustainability Report 2015	Core

a) There is no explicit 'in accordance' option declared, but the report contains a complete G4 Content Index.
b) Not yet in the database, the latest there is CR Report 2014.

Source: Own compilation, mainly based on http://database.globalreporting.org

14.5.4 Latin America and Caribbean

As of the end of August 2016, the GRI database listed only ten GRI reports or references in accordance with G4, published in 2015 or later by companies in the chemical sector in Latin America and Caribbean.

Table 93: Selected Latin American and Caribbean chemical companies with sustainability/CSR reports in accordance with GRI G4 in 2015/16 (non-exhaustive list; in the case of annual reporting only the latest report is cited)

Country	Company: Report (2015/16)	GRI G4
Argentina	Profertil: Reporte de Sustentabilidad 2014	Core
	Dow Argentina: Balance de Sustentabilidad 2014	Core
Brazil	Braskem: 2014 Annual Report	Core
	Dow Química Brasil: Relatório de Sustentabilidade 2014	Core
	Elekeiroz: Annual Sustainability Report 2014	Comprehensive
	FERTILIZANTES HERINGER: Relatório de Sustentabilidade 2014	Core
	QUIMICRYL S/A: 4º RELATÓRIO DE SUSTENTABILIDADE | G4	Core
Chile	Empresa Nacional del Petroleo (ENAP): Reporte de Sostentabilidad 2014	Core
	SQM: 2014 Sustainability Report	Core
Mexico	Praxair México y Centro America: Informe de Desarrollo Sustentable 2014	Core

Source: Own compilation, mainly based on http://database.globalreporting.org

14.5.5 Northern America

As of the end of August 2016, the GRI database listed only nine GRI (stand-alone or integrated) reports or references in accordance with G4, published in 2015 or later by companies in the chemical sector in North America. Some current reports have not yet been listed, but were available on the websites of the respective companies.

Table 94: Selected North American chemical companies with sustainability/CSR reports in accordance with GRI G4 in 2015/16 (non-exhaustive list)

Company: Report (2015/16)	GRI G4
Arizona Chemical: Advancing Our Sustainability Strategy: 2014 Sustainability Report	Core
Ashland: Sustainability Report 2014	Core
Birla Carbon: Sustainability Report 2015	Comprehensive
Dow Chemical: Dow 2015 Sustainability Report	Comprehensive
DuPont: DuPont 2015 Global Reporting Initiative Report	Core
Ecolab: 2014 Corporate Sustainability Report	Core
JSR Micro Inc. : JSR Micro 2014 Corporate Social Responsibility Report	Core
Northrop Grumman: 2014 Corporate Responsibility Report	Core
Pinova Holdings: Creating Sustainable Value – Corporate Stewardship 2014	Core

Source: Own compilation, mainly based on http://database.globalreporting.org

14.5.6 Oceania

As of the end of August 2016, the GRI database listed only one GRI report in accordance with G4 (option: Undeclared), published in 2015 or later by companies in the chemical sector in Oceania.

Table 95: Selected Oceanian chemical companies with sustainability/CSR reports in accordance with GRI G4 in 2015/16 (non-exhaustive list, mainly based on http://database.globalreporting.org)

Country	Company: Report (2015/16)	GRI G4
Australia	Orica: Sustainability Report 2015	Undeclared [a)]

a) There is no explicit 'in accordance' option declared, but the report contains a complete G4 Content Index.

Source: Own compilation, mainly based on http://database.globalreporting.org

14.6 Annex VI: Chemical Footprint Project (cfp)

14.6.1 Characterization

"The Chemical Footprint Project is a new initiative for measuring corporate progress to safer chemicals. It provides a metric for benchmarking companies as they select safer alternatives and reduce their use of chemicals of high concern."[309]

The vision behind the chemical footprint project (cfp) is "a world where chemicals are healthy for people and the environment; where disease rates for cancer, infertility, asthma, and learning disabilities are falling rapidly; and where governments and markets reward healthy products. To achieve this vision the Chemical Footprint Project tracks, disseminates, and benchmarks corporate progress to safer chemicals in products, manufacturing, and supply chains."[310]

[309] http://www.chemicalfootprint.org/learn

[310] https://www.chemicalfootprint.org/about/overview

"The CFP Survey is designed to be completed by manufacturers and brands. While the Survey is applicable to any manufacturer or brand, it was developed using information on the chemicals management practices of the following sectors: automotive, building products, consumer packaged goods, medical devices, electronics, and apparel/footwear/outdoor. Survey results and scores can be used by investors and purchasers to help identify chemical management leaders in specific product categories of interest."

Further details are provided in Table 96. The information was mainly sourced from cfp's website[311] and its 2016 Annual Report[312].

Table 96: The Chemical Footprint Project (cfp): Short Characterization

Subject	Information
Name / Title	The Chemical Footprint Project (cfp)
URL	https://www.chemicalfootprint.org
Type of organization	Project
Coverage/region	Global (?)
Institution(s) behind initiative/approach	Founders: Clean Production Action, Lowell Center for Sustainable Production at the University of Massachusetts Lowell, Pure Strategies (sustainability consultants)
Legal information	n.a.
Governance bodies	**Steering Committee** [313] **Technical Committee** (served as an ad hoc group that advised the development of the 2014 pilot version of the Chemical Footprint Project Survey)[314]
President/CEO/Chairman	Dr. Mark S. Rossi, project lead (Executive Director, Clean Production Action)
Year of foundation	2014
Budget/funding	► Support of investors representing $2.3 trillion in assets under management and institutional purchasers with over $70 billion in purchasing power
Links/closeness to other stakeholders	► See institutions behind initiative ► BizNGO www. http://biznGO.org
Target audience and sectoral/geographical scope	► "The Survey is designed for manufacturers and brands, who participate as CFP Responders. CFP Signatories are investors, retailers, large-scale purchasers, and NGOs that encourage manufacturers and brands to participate as Responders."
Self-declared goal	► "The mission of the Chemical Footprint Project is to transform global chemical use by measuring and disclosing data on business progress to safer chemicals. It provides a tool for benchmarking companies as they select safer alternatives and reduce

311 https://www.chemicalfootprint.org

312 Chemical Footprint Project: 2016 Annual Report. Available via https://www.chemicalfootprint.org

313 https://www.chemicalfootprint.org/about/steering-committee

314 Ten experts from U.S. Green Building Council, Practice Greenhealth, ChemSec, Electronics Takeback Coalition, Investor Environmental Health Network, Seagate, McFadden and Associates, LLC., Scivera, HP, Inc., Construction Specialties, Inc. https://www.chemicalfootprint.org/about/technical-committee

Subject	Information
	their use of chemicals of high concern." ► Goal is "avoiding chemicals that can cause adverse health effects such as cancer, birth defects, and learning disabilities, along with using safer alternatives, the Chemical Footprint Project adds the "H" of human Health to Environmental, Social, and Governance (ESG) factors." (2016 Annual Report)
Definition of sustainable chemistry OR sustainability	No definition.
Concept of selected indicators	► Focus lies on Chemicals of High Concern (CoHC) [315]: ► Management strategy (including supply chain) (20 points) ► Chemical inventory (30 points) ► Footprint measurement (30 points) ► Public disclosure and verification (20 points)
Launch year, change in concept (if any) since then	2014: Starting pilot version 2015: First survey completed (24 participants) 2016: This year's Chemical Footprint Project Survey will close on 31 January 2017. Changes:[316] a) Changing of "the reference list for chemicals of high concern (CoHCs) from the California Candidate Chemicals List used in 2015 to the Chemical Footprint Project (CFP) 2016 CoHC list. The CFP 2016 CoHC List is compiled from 15 lists of hazardous chemicals developed by governments and other authoritative bodies that align with the CFP definition for a 'chemical of high concern'." b) Additional option to questions F2 and F3 for measuring a company's chemical footprint. "Participating companies may: a) measure against the full CFP 2016 CoHC list (approximately 2,200 chemicals) or b) measure against a subset of the CFP 2016 CoHC List, specifically the European Union's list of 169 Candidate Substances of Very High Concern. If a company chooses to use the EU REACH Candidate SVHC list, it will receive fewer points than if it uses the CFP 2016 CoHC list."
Proposed instruments and measures for implementation	Voluntary participation in survey, voluntary publication of participation and score.
Status of implementation (e.g. description of best practice etc.)	2015 survey completed with 24 participants. Responses of all participating companies are evaluated and reported anonymously in an Annual Report. Responses of companies that agreed to make them public for the 2015 reporting year are available here https://www.chemicalfootprint.org/assess/results. No company has published its score.
Status and type of monitoring	n.a.

[315] Definition according to cfp: (CoHC) as a chemical that meets any of the following criteria: 1) carcinogenic, mutagenic, or toxic to reproduction (CMR); 2) persistent, bioaccumulative and toxic substance (PBT); 3) any other chemical for which there is scientific evidence of probable serious effects to human health or the environment that give rise to an equivalent level of concern (for example, an endocrine disruptor or neurotoxicant); or 4) a chemical whose breakdown products result in a CoHC that meets any of the above criteria. https://www.chemicalfootprint.org/learn/faqs

[316] Chemical Footprint Project: 2016 Guidance Document.

Subject	Information
including e.g. time series of indicator measurements	
Stakeholder engagement	BizNGO Clean Production Action http://www.cleanproduction.org/
Additional information	► Further CPA programmes are ► GreenScreen® for Safer Chemicals http://www.greenscreenchemicals.org/ ► BizNGO (see sub-chapter 7.3)

Source: Own compilation, mainly based on cfp's website https://www.chemicalfootprint.org

14.6.2 Application

"Chemical footprinting is the process of assessing progress toward the use of safer chemicals and away from CoHCs. Clean Production Action defines chemical footprint as the number and mass of CoHCs used in manufacturing and supply chains, and contained in the final product."[317]

The Chemical Footprint Project measures overall corporate chemicals management performance through a 20-question survey, with a possible top score of 100 points, which evaluates:

- "Management Strategy (20 points): This section asks about the scope of corporate chemical policies and their integration into business strategy, accountability, and employees' incentives for safer chemical use, as well as support of public policies for safer chemicals.
- Chemical Inventory (30 points): This section asks about the efforts a company has taken to identify chemicals of high concern (CoHCs) in its products, the extent of chemical data collected from its suppliers, and its systems for managing chemical data and ensuring supplier compliance with its reporting requirements.
- Footprint Measurement (30 points): This section asks about the goals that a company sets to reduce chemicals of high concern, its efforts to establish a baseline chemical footprint and measure progress, and its process for assessing and implementing safer alternatives.
- Disclosure and Verification (20 points): This section asks if a company publicly discloses the chemicals in its products beyond regulatory requirements, if it discloses its CFP Survey responses and scores, and if its answers have been independently verified by a third party."[317]

In 2015, a selected group of 24 leading edge businesses – both small ($ millions in annual revenue) and large ($ tens of billions in annual revenue) – participated in the Chemical Footprint Project and were awarded a score for their corporate chemicals management practices. Participants included: Levi Strauss & Co.; Seagate Technology, PLC; Johnson & Johnson; GOJO Industries; Becton, Dickinson and Company; Beautycounter; and California Baby, among others. The survey questions are shown in Figure 12, Figure 13 shows an example of chemicals data collected from suppliers and the respective answers from the participating companies. The questions are available in detail in cfp's 2016 Annual Report.

No information could be obtained regarding how points are distributed. For example, for I3 (Figure 13) there are four questions, but 5 points. The criteria are not balanced, e.g. there is a large difference between whether a company requests (c) or requires (d) suppliers to provide chemical ingredient information.

[317] https://www.chemicalfootprint.org/learn/faqs

Figure 12: Chemical Footprint Project: 2015 Survey questions by key performance category

Management Strategy (M) (20 points)	**Footprint Measurement (F) (30 points)**
M1. Does your company have a chemicals policy that aims to avoid chemicals of high concern (CoHCs)? (4 points) M2. Does your company have a chemicals policy that in addition to avoiding chemicals of high concern includes a preference for the use of safer alternatives? (4 points) M3. Is reducing CoHCs and/or advancing safer alternatives beyond regulatory requirements integrated into your company's business strategy? (4 points) M4. How does your company engage in the following types of public policy initiatives to promote the use of safer chemicals? (4 points) M5. What job responsibilities and incentives does your company have in place to ensure implementation of your chemicals policy? (4 points)	F1. Has your company set goals for reducing CoHCs in the products you sell and measured progress against these goals? (6 points) F2. How does your company measure its baseline chemical footprint? (6 points) F3. Over the past two years how much have intentionally added CoHCs in your products changed? (6 points) F4. How does your company assess the hazards of chemicals in its products beyond regulatory requirements? (6 points) F5. How does your company encourage the use of safer alternatives to CoHCs? (6 points)
Chemical Inventory (I) (30 points)	**Public Disclosure and Verification (D) (20 points)**
I1. What steps has your company taken to manage legally restricted CoHCs? (5 points) I2. What actions does your company take to develop a Beyond Restricted Substances List and determine their presence in your products? (5 points) I3. What chemical information does your company collect from suppliers? (5 points) I4. For what percentage of products sold by your company do you collect chemical ingredient information? (5 points) I5. What capabilities does your company have for managing data on chemical ingredients in its products? (5 points) I6. How does your company assure conformance with your chemicals policy? (5 points)	D1. What information beyond legal requirements does your company disclose about the chemical ingredients in its products? (8 points) D2. Does your company agree to publicly disclose that it participated in the Assessment Tool? (4 points) D3. Does your company agree to publicly disclose its responses to the questions in the Assessment Tool? (4 points) D4. Have any of your company's responses to the questions in the Assessment Tool been verified by an independent, third party? (4 points)

Source: Chemical Footprint Project: 2016 Annual Report. Available via https://www.chemicalfootprint.org

Figure 13: Chemical Footprint Project: 2015 Survey question concerning chemical information collected from suppliers

„I3: Chemical information collected from suppliers

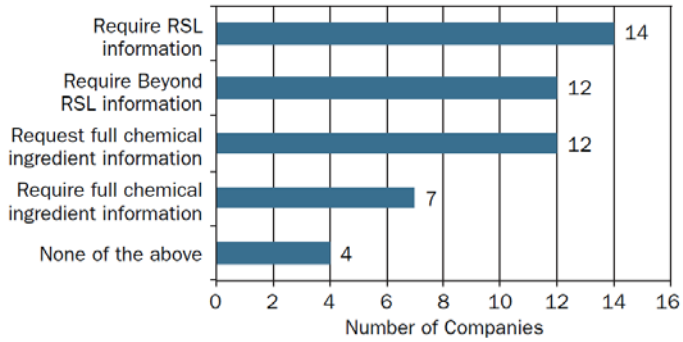
I 3. What chemical information does your company collect from suppliers? (5 points)

Response Options

Check all that apply. Our company:

a. requires suppliers to provide chemical information as delineated in our Restricted Substances List
b. requires suppliers to provide chemical information as delineated in our Beyond Restricted Substances List
c. requests suppliers to provide chemical ingredient information
d. requires suppliers to provide chemical ingredient information
e. has not addressed chemicals with supply partners at this time."

Appendix 4 Figure 3: Indicator I3 Survey Responses



Source: Chemical Footprint Project: 2016 Annual Report. Available via https://www.chemicalfootprint.org

"Key findings include:

- Senior leadership matters: The 29% of firms with Board-level oversight or senior management incentives performed better overall than firms with no such accountability.
- Companies need comprehensive policies: Without policies that address chemical hazards in manufacturing, supply chains, and packaging – in addition to products – companies face hidden liabilities and chemical risks.
- Disclosure lags practice: Across every category – Management, Inventory, Footprint, and Disclosure – companies have more chemicals management practices in place than they share publicly. For example, 83% have a legally restricted substances list, but only 17% of those companies make that list public.
- "Design for Health" sets leading edge: companies whose entire product portfolios are based on minimizing or eliminating chemicals of high concern performed well above average."[318]

14.6.3 Evaluation

According to the Chemical Footprint Project's 2016 Annual Report, the cfp "sets a new standard for evaluating and comparing companies on their policies, programs, and practices for managing chemicals. By assessing companies on their overall progress in avoiding chemicals that can cause adverse health effects such as cancer, birth defects, and learning disabilities, along with using safer alterna-

[318] https://www.chemicalfootprint.org/news/article/chemical-footprint-project-first-report

tives, the Chemical Footprint Project adds the "H" of human Health to Environmental, Social, and Governance (ESG) factors – thereby filling a critical missing gap in the sustainability mosaic."

Other experts point to the limitations of carbon footprint as an indicator of environmental sustainability: "… environmental sustainability concerns not just climate change but also other environmental problems, like chemical pollution or depletion of natural resources, and the focus on CFP brings the risk of problem shifting when reductions in CFP are obtained at the expense of increase in other environmental impacts. But how real is this risk? Here, we model and analyze the life cycle impacts from about 4000 different products, technologies, and services taken from several sectors, including energy generation, transportation, material production, infrastructure, and waste management. By investigating the correlations between the CFP and 13 other impact scores, we show that some environmental impacts, **notably those related to emissions of toxic substances**, often do not covary with climate change impacts. In such situations, carbon footprint is a poor representative of the environmental burden of products, and environmental management focused exclusively on CFP runs the risk of inadvertently shifting the problem to other environmental impacts when products are optimized to become more "green". These findings call for the use of more broadly encompassing tools to assess and manage environmental sustainability."[319]

Table 97: Evaluation of the approach of the Chemical Footprint Project

Subject	Comment
Consistency of sustainable chemistry definition and its application in the approach	No definition, project mainly refers to hazardous chemicals (CoHC)
Consistency of indicator concept and how it is monitored	n.a.
Role of SDGs in the concept	Not mentioned.
Probability of implementation	Implemented.
Overall impression	Can be a useful tool, but more details are needed.

Own compilation

14.7 Annex VII: bluesign® (informal, is LABEL and therefore out of scope)

The bluesign® is a label used to distinguish textile products which have been produced with approved chemicals. bluesign® excludes hazardous substances from the manufacturing process, establishes guidelines for the use of chemicals and controls their compliance.

The bluesign® standard conforms to consumer and environmental protection standards worldwide and covers the five aspects of consumer protection, waste water, exhaust air, work safety and resource productivity. Before production, which components and processes correspond to the given criteria is determined. The bluesign standard thus creates transparency for the entire textile supply chain.

"Many global brands are already bluesign® system partners, selling bluesign® system labeled textiles. "With the Input Stream Management, bluesign® system partners only use approved chemicals and components according to the high standards. They have to go through rigorous on-site tests in

[319] Limitations of Carbon Footprint as Indicator of Environmental Sustainability. Alexis Laurent, Stig I. Olsen, and Michael Z. Hauschild, Environ. Sci. Technol., 2012, 46 (7), pp 4100–4108, DOI: 10.1021/es204163f, Publication Date (Web): March 23, 2012

order to verify compliance with bluesign® criteria. Once, they meet the high requirements of the bluesign® criteria their products will be awarded the bluesign® system labels. That applies to textile manufacturers and chemical suppliers too, who produce their components and raw materials in compliance with the bluesign® criteria."[320]

"Input Stream Management requires working with partners from the chemical industry. To make sure that the bluesign® criteria are met, the EHS (Environment, Health & Safety) knowledge of the chemical industry partners is reviewed and audited on site.

The homologation of the chemical components according to the bluesign® system and their publication in the bluesign® bluefinder show that the chemical supplier is a reliable partner for potential business partners. …

Tools such as the bluesign® bluetool or the bluesign® audit help suppliers of chemical products to satisfy the constantly changing demands of manufacturers, retailers and brands. In addition, EHS = (Environment, Health, Safety) inquiries and individual RSL (= Restricted Substances List) references are reduced since the BSSL (bluesign® system substances list) automatically excludes all harmful substances listed in the relevant RSLs. This saves unnecessary workload and associated costs. The chemical expertise and the manufactured products are certified by bluesign technologies ag as an independent entity."[321]

Within this system, the bluesign® criteria define the requirements for inputs, production site, and products.

Concerning input, the system comprises ratings (what is referred to as **homologation**) for each applied chemical component based on eco-toxicological criteria: "The threshold values for substances in applied chemicals include detailed risk assessments according to the principles of sustainability. For the practical evaluation, the strictest calculated value will be decisive. An auxiliary will not only be evaluated according to its individual contents, but also on its environmental impact regarding the complete process chain. Its specific application within the process also is considered in the assessment."

In accordance with the specifications, complex eco-toxicological information is categorized in a clear and easy-to-use way:

- "Blue" category: Components meet all the bluesign® criteria and requirements
- "Grey" category: Components shall only be used under certain appropriate conditions
- "Black" category: Components do not meet the bluesign® criteria" [322]

The bluesign® criteria for chemical assessment (homologation), for bluesign® products, for production sites, the BSSL (bluesign® system substances list), and further information material are available from the bluesign® website[323].

The reference list of bluesign®'s chemical suppliers includes over 80 companies.

Homepage: http://www.bluesign.com/

[320] http://www.bluesign.com/consumer/how-to-find-it#.WB88qVugMUI

[321] http://www.bluesign.com/industry/chemical-suppliers#.WB88KFugMUI

[322] http://www.bluesign.com/industry/bluesign-system/criteria/criteria-for-homologation#.WBpAwVugMUI

[323] http://www.bluesign.com/de/industry/infocenter/downloads#.WB9D_lugMUI