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Strategic Approach to International Chemicals Management

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Progress towards the achievement of the 2020 overall objective of the sound management of chemicals

A submission by UNEP - Analysis of Stakeholder Submissions on Sustainable Chemistry Pursuant to UNEA Resolution 2/7

Note by the secretariat

The secretariat has the honour to circulate, in the annex to the present note, an analysis of stakeholder submissions on sustainable chemistry pursuant to UN Environment Assembly Resolution 2/7. The report is presented in the annex as received from the United Nations Environment Programme and has not been edited by the secretariat.

* SAICM/OEWG.3/1.

Annex

Analysis of Stakeholder Submissions on Sustainable Chemistry Pursuant to UNEA Resolution 2/7

A report from the United Nations Environment Programme

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Executive Summary

This report responds to a mandate provided through Resolution 2/7, adopted at the second session of the United Nations Environment Assembly in 2016. The resolution requested stakeholders having relevant experience with the issue of sustainable chemistry to submit best practises by June 2017 and the Executive Director of UN Environment to prepare a report in the first quarter of 2018 analysing the information received.

Following an introduction, Section 2 of the report provides a snapshot of initiatives and actions by stakeholders referring to sustainable chemistry that were identified via desk research. It notes that the concept is widely used by stakeholders around the world, with some having developed a definition (e.g. the Organisation for Economic Co-operation and Development). Green chemistry, a related and complimentary concept focusing on scientific aspects of chemistry, is also briefly discussed.

Section 3 presents an analysis of submissions made by stakeholders in response to Resolution 2/7. The submitted cases address various stages of the chemical and waste life cycle and illustrate stakeholder perceptions that sustainable chemistry plays a role in achieving the Sustainable Development Goals Target 12.4 on the sound management of chemicals and wastes and related aspects of Sustainable Development Goal 12 on sustainable consumption and production (e.g. resource efficiency). The cases also address and highlight the contribution of sustainable chemistry to other Sustainable Development Goals and Targets (e.g. zero hunger, climate change). This provides an expanded and complementary view concerning the role of chemistry in achieving broader development objectives, taking into account environmental, social and economic sustainability dimensions. Given that an agreed international definition or assessment framework to identify best practises in sustainable chemistry does not exist, all submitted cases were taken into account and their inclusion does not imply any judgement by UN Environment.

Section 4 provides an analysis of findings from a survey undertaken by UN Environment to elicit feedback from stakeholders on the sustainable chemistry concept. Responses reveal a broad understanding and interpretation of sustainable chemistry. In response to the question how sustainable chemistry could contribute at the international level, the idea of sustainable chemistry being seen as a reference or assessment framework that helps to analyse the contribution of chemistry to all three dimensions of sustainable development and implementation of the 2030 Agenda for Sustainable Development received the strongest support. Sustainable chemistry as a new type of chemistry and/or as a destiny or end goal to be achieved were also supported by a large majority. The majority of respondents also felt that (despite some stakeholders having developed a definition) an international definition of sustainable chemistry would be valuable.

Section 5 concludes that sustainable chemistry is seen by stakeholders as an important component to achieve the sound management of chemicals and waste and is therefore relevant for the discussions on chemicals and waste management beyond 2020. Stakeholder perspectives also suggest that the concept helps to examine the contribution of chemistry in achieving the broader 2030 Agenda Sustainable Development Goals and Targets, such as zero hunger, climate action, safe housing, workers' health, innovation, and gender equality, while addressing all three dimensions of sustainable development. However, since it is not a scientific term, but rather a socially constructed concept, the exact nature of sustainable chemistry, what it entails and how it can contribute needs further reflection. Given the interest of stakeholders, including many from developing countries, in the concept, a practical starting point could be to develop a better understanding of sustainable chemistry opportunities globally. This could include development of practical guidance on sustainable chemistry as well as exploring how developing countries could be supported in potential related capacity building efforts.

Introduction

Resolution 2/7 on the sound management of chemicals and waste, adopted by the United Nations Environment Assembly at its second session, held on 23-27 May 2016, in section III, paragraph 20 to 21 invited "countries, international organizations and other interested stakeholders, including the private sector, having relevant experience with the issue of sustainable chemistry to submit to the United Nations Environment Programme secretariat, by 30 June 2017, best practices, indicating how these may enhance the sound management of chemicals, inter alia through the implementation of the 2030 Agenda for Sustainable Development, as well as the Strategic Approach to International Chemicals Management and chemicals- and waste-related multilateral environmental agreements".

The resolution also requested the Executive Director "to prepare a report in the first quarter of 2018 analysing the information received to assist the Strategic Approach to International Chemicals Management in considering the opportunities presented by sustainable chemistry, including linkages to sustainable consumption and production policies, and the possibilities that sustainable chemistry may offer of contributing to the achievement of the 2030 Agenda".[1]

This report responds to this mandate. It provides a brief review of initiatives by stakeholders explicitly referring to sustainable chemistry identified through desk research, analyses stakeholder submissions made in response to Resolution 2/7, and summarizes results of a UN Environment Survey on the topic, administered in 2017 through collaboration of the Chemicals and Health Branch, Economy Division, UN Environment and the Secretariat of the Basel, Rotterdam and Stockholm Conventions. The report concludes with a brief and forward-looking analysis with the aim to advance a global understanding of sustainable chemistry, as the international community is undertaking the intersessional process to prepare by 2020 recommendations regarding the Strategic Approach and the sound management of chemicals and waste beyond 2020, initiated through the International Conference on Chemicals Management.

Since an agreed international definition or reference/assessment framework to identify best practises in sustainable chemistry does not exist, all submitted cases were considered in this report, with the exception of those which did not provide sufficient information and where no references were provided. In light of the above, references to "best practices" or sustainable chemistry cases mentioned in this report do not imply any judgement by UN Environment. Hereinafter, the term 'cases' is used to refer to what stakeholders provided in response to the invitation to submit best practices. In line with the mandate received, the purpose of this report is not to develop or propose a definition of sustainable chemistry, but rather to share information and facilitate further discussions at the international level.

[1] *UNEA Resolution 2/7. Sound management of chemicals and waste*. UNEP/EA.2/Res.7, *section III, paragraph 20 to 21*. United Nations Environment Programme, Nairobi.

1. Sustainable Chemistry: A Snapshot of Initiatives and Actions

The sustainable chemistry concept has been used by a number of initiatives and a range of stakeholders for many years. Closely related activities are undertaken within the framework of, and using the term 'green chemistry', including in many developing countries and countries with economies in transition.[2] A wide range of initiatives have been undertaken over the past decades that could be considered to be compatible with concepts such as green chemistry and sustainable chemistry.

Sustainable chemistry is seen to be a holistic concept by many (further discussed below), as mirrored in the use of the word "sustainable", reflecting reference to the 2030 Sustainable Development Agenda and its three dimensions (economic, social and environmental). Green chemistry is specified through the widely cited 12 principles which focus on "safer" and less resource intensive chemistry (see Box 1). It has been defined as "the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and applications of chemical products".[3] Green chemistry can thus be seen as focusing on scientific aspects of chemistry. The use of the term "chemistry" in the sustainable chemistry concept can be understood as implicating a similar focus; yet, as further discussed in this report, a number of stakeholder perspectives suggest a wider scope. Many stakeholders use the terms green and sustainable chemistry interchangeably.

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 (e.g. solvents, separation agents) should be made unnecessary wherever possible and innocuous when used.
6. Design for energy efficiency: energy requirements of chemical processes should be recognized for their environmental and economic 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 derivatisation (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.

[2] Examples of green chemistry initiatives include the Royal Society of Chemistry's journal 'Green Chemistry', the International Union of Pure and Applied Chemistry's International Conferences on Green Chemistry, the Green Chemistry and Commerce Council, the United Nations Industrial Development Organization global green chemistry project funded by the Global Environment Facility, and Green Chemistry Institute of the American Chemical Society, which has chapters in more than twenty countries, including Argentina, China, India, and South Africa (RSC. (2018). *Green Chemistry*. Weblink (accessed 14 February 2018); IUPAC. (2018). *8TH IUPAC International Conference on Green Chemistry.* Weblink *(accessed 14 February 2018);* GC3. (2018). *Advancing Green Chemistry Across Sectors and Supply Chains.* Weblink *(accessed 14 February 2018)*; ACS. (2018), *ACS Green Chemistry Institute*. Weblink (accessed 22.02.2018).

[3] (Anastas, P.T. and Warner, J.C. (1998). Green Chemistry: Theory and Practice. pp.11, 30. Oxford University Press. London).

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 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.

Box 1: The 12 Principles of green chemistry (Anastas and Warner 1998)

Given the focus of the UNEA resolution on sustainable chemistry, and in light of the significant number of green chemistry initiatives, this section provides a brief and non-comprehensive overview of initiatives which explicitly use the term 'sustainable chemistry', identified through desk research. This overview does not seek to assess the impact or relevance of the initiatives, e.g. in advancing the sound management of chemicals and waste or implementation of the 2030 Agenda, but rather seeks to provide an illustration of its use by a wide range of stakeholders. Moreover, initiatives using related concepts such as "sustainability of chemistry", "sustainable chemical industry", or "sustainable chemicals", although also closely related, are also not covered.[4] Future work could explore these and other related concepts in more detail.

2.1 Academia and Civil Society

Academic conferences

Since 2003 and every second year, the 'International Conference on Green and Sustainable Chemistry', sponsored by a range of academic, research and other institutions around the world, is organized in different countries and regions with the aim of highlighting significant advances related to the discovery, development and application of green and sustainable chemistry and engineering leading to the betterment of the human condition.[5] Since 2016, Elsevier is holding the 'Green and Sustainable Chemistry Conference' series. Organised on an annual basis and featuring a number of speakers and participants from developing countries, the conference's objective is to bring together international researchers from academia and industry, from authorities and other institutions to communicate and share the latest developments across the broad and diverse fields of green and sustainable chemistry.[6] Conferences are also being organized in developing countries and economies in transition. For instance, the 'Asia-Oceania Conference on Green and Sustainable Chemistry', organized since 2007, has among others been hosted in India and the People's Republic of China.[7]

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[4] There are a number of initiatives using these terms, for instance the 'Road Map Document for a Sustainable Chemical Industry' (European Commission. Weblink (2013). (accessed 27.02.2018), the 'Guide on Sustainable Chemicals' (German Environment Agency. (2011). Weblink (accessed 27.02.2018), the Boston Consulting Group's 'Making a Business Case for Sustainability of Chemicals' (BCG. (2017). Weblink (accessed 27.02.2018), and the voluntary commitment of BASF to beat pollution via a methodology to assess sustainability across the product portfolio made at the third session of the United Nations Environment Assembly (UN Environment (2017). Annex 4: #BeatPollution Voluntary Commitments from Business. United Nations Environment Programme, Nairobi.).

[5] Nature. (2017). *8th International Conference on Green and Sustainable Chemistry.* Weblink (accessed 14 February 2019).

[6] Elsevier. (2018). *3rd Green & Sustainable Chemistry Conference*. Weblink (accessed 14 February 2018). Abstracts submitted for the conference include a discussion of green and sustainable chemistry education in India, submitted by researchers from the People's Education Society University (Veerabhadraswarmy, M and Anilkumar, H. G. (n.d.). *Propagation of green and sustainable chemistry education in Indian context – An overview.* Weblink (accessed 27.02.2018).

[7] The Energy and Research Institute. (2915). The 5th Asia-Oceania Conference on Green and Sustainable Chemistry. Weblink (accessed 27.02.2018); City University of Hong Kong. (2016). 6th Asia-Oceania Conference on Sustainable and Green Chemistry. Weblink (accessed 27.02.2018)

Academic journals and literature

Several academic journals focus on sustainable chemistry. This includes the American Chemical Society's 'Sustainable Chemistry and Engineering' journal, founded in 2013 to address challenges of sustainability in the chemical enterprise and advance principles of green chemistry and green engineering.[8] Elsevier's 'Sustainable Chemistry and Pharmacy', launched in 2015, employs an interdisciplinary approach and aims to contribute to a better understanding of concepts related to sustainable chemistry or sustainable pharmacy, including the circular economy.[9] Elsevier's journal 'Current Opinion in Green and Sustainable Chemistry' seeks to advance a better understanding where and how chemistry itself can be made more sustainable and whereby chemistry can contribute to sustainability in general.[10] In addition, numerous articles published in various scientific journals feature titles using the term sustainable chemistry, including from a developing country perspective.[11] A recent publication by Anastas and Zimmerman (2018) explored the potential of sustainable chemistry in contributing towards the achievement of the Sustainable Development Goals (SDG)[12].

Curricula and research

The concept of sustainable chemistry has also been integrated in curricula of universities, under the heading of sustainable chemistry research, courses and Master's programmes. For example, the Research Institute for Sustainable Chemistry established by the National Institute of Advanced Industrial Science and Technology in Japan is engaged in research and development of sustainable chemistry since 2015.[13] Sustainable chemistry is also a research priority area at the University of Amsterdam, with a total equivalent of 90 dedicated researchers.[14] McGill University in Canada recently launched the 'Creating Sustainable Materials for the Future' transdisciplinary research programme under its 'Sustainability Systems Initiative', that focuses on the design, development, evaluation and use of safe and sustainable materials (i.e., functional materials and molecules)[15]. Universities offering postgraduate courses on sustainable chemistry include the University of Valencia, the University of Nottingham, Leuphana University, the New University of Lisbon and the University of Venice.[16] As another example, the European Association for Chemical and Molecular Sciences is organizing regular European Sustainable Chemistry Awards to recognise individuals or small research groups which make an outstanding contribution to sustainable development by applying green and sustainable chemistry.[17]

Universities are also the origin of start-up initiatives seeking to advance sustainable chemistry. In the context of a workshop in 2017 on 'Advancing Entrepreneurship and Start-up Initiatives for Sustainable

[8] ACS. (2018). *ACS Sustainable Chemistry & Engineering*. Weblink (accessed 14 February 2018).
[9] Elsevier. (2018). *Sustainable Chemistry and Pharmacy*. Weblink (accessed 14 February 2018).
[10] Elsevier. (2018). *Current Opinion in Green and Sustainable Chemistry*. Weblink (accessed 14 February 2018).
[11] Barra, R. and Gonzalez, P. Sustainable chemistry challenges from a developing country perspective: Education, plastic pollution and beyond. *Current Opinion in Green and Sustainable Chemistry, 9:40-44*. https://doi.org/10.1016/j.cogsc.2017.12.001.
[12] Anastas, P.T. and Zimmerman, J.B. (2018). The United Nations sustainability goals: how can sustainable chemistry contribute? Current Opinion in Green and Sustainable Chemistry. https://doi.org/10.1016/j.cogsc.2018.04.017
[13] AIST. 2018. *Research Institute for Sustainable Chemistry*. Weblink (accessed 14 February 2018).
[14] University of Amsterdam. (2018). *Suschem at the UvA*. Weblink (accessed 14 February 2018).
[15] Mc Gill University. (2019). Creating Sustainable Materials for the Future. Weblink (accessed 15.02.2019).
[16] The University of Nottingham. (2018). *Green and Sustainable Chemistry MSc.* Weblink (accessed 14 February 2018); The University of Valencia. (2018). *Master's Degree in Sustainable Chemistry*. Weblink (accessed 14 February 2018); Faculdade de Ciencias e Ecnologia. (2018). *Phd in Sustainable Chemistry*. Weblink (accessed 27.02.2018); and Ca' Foscari University of Venice. (2018). *Master's Degree Programme in Sustainable Chemistry and Technologies.* Weblink (accessed 14 February 2018); Leuphana University of Lüneburg. (2018). Institute of Sustainable and Environmental Chemistry. Weblink (accessed 12 October 2018).
[17] EuChems. (2017). *European Sustainable Chemistry Award.* Weblink (accessed 14 February 2018).

Chemistry: Learning from Case Studies', several case examples were provided by researchers from Universities and research institutions, including from Colombia and Nigeria.[18] Moreover, universities are partnering with the private sector in the field of sustainable chemistry: In 2013, the São Paulo Research Foundation (FAPESP) and a British pharmaceutical company announced the creation of a 'Centre of Excellence for Sustainable Chemistry' in Brazil.[19]

Civil society

The International Persistent Organic Pollutants Elimination Network, comprised of several hundred participating organizations in more than hundred countries, presented a document exploring the role and potential of green chemistry and sustainable chemistry in order to inform discussions at the first meeting of the intersessional process to prepare recommendations regarding the Strategic Approach and the sound management of chemicals and waste beyond 2020.[20] On the occasion of the 'Conference on Mainstreaming Sustainable Chemistry' (Berlin, 17-18 May 2017), the International Persistent Organic Pollutants Elimination Network and Women in Europe for a Common Future presented a position paper providing recommendations relevant for the concept, supported by a large number of civil society organizations.[21] Some civil society organizations are referring to sustainable chemistry on their websites, for example The Natural Step International[22], which links the concept to the question of how the potential of chemical to contribute to sustainability can be unlocked.

As an example of concrete action, during the workshop on 'Advancing Entrepreneurship and Start-up Initiatives for Sustainable Chemistry: Learning from Case Studies', a non-governmental organization based in Ghana presented a project advancing organic farming.[23] The concept of sustainable chemistry has also been picked up by the World Economic Forum, occupying, for example, a prominent role in the forthcoming report on 'Collaborative Innovation towards the Sustainable Development Goals'[24].

2.2 Private Sector

Initiatives using the term 'sustainable chemistry' by the private sector are being undertaken throughout the supply chain by the chemical industry, downstream industries and retailers. The chemical company Solvay, for example, dedicated itself to the achievement of five objectives "for a sustainable chemistry by 2025", framed under the headings to "contribute to society, innovate sustainable solutions, and act responsibly".[25] Dow Chemicals developed a 'Sustainable Chemistry Index' as a means of evaluating products, such as life cycle benefits and social needs. Dow Chemicals committed itself to the '2015 Goal on Sustainable Chemistry' to, among others, "increase the percentage of sales to 10 percent for products that are highly advantaged by sustainable chemistry", as assessed via the index.[26]

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[18] UN Environment. (2017). *Advancing Entrepreneurship and Start-up initiatives for Sustainable Chemistry: Learning from Case Studies'* (UN Environment. Weblink (accessed 27.02.2018).

[19] GlaxoSmithKline. (2013). GSK to create a new Centre of Excellence for Sustainable Chemistry in Brazil. Weblink (accessed 27.02.2018).

[20] IPEN. (2017). *Beyond 2020: Green chemistry and sustainable chemistry.* Weblink (accessed 22.02.2018)

[21] IPEN and WECF. (2017). *Beyond 2020: Sustainable Chemistry – NGO recommendations'*. Weblink (accessed 22.02.2018)

[22] https://thenaturalstep.org/chemicals/

[23] UN Environment. (2017). *Advancing Entrepreneurship and Start-up initiatives for Sustainable Chemistry: Learning from Case Studies' (UN Environment*. Weblink (accessed 27.02.2018).

[24] World Economic Forum (2018). *Chemistry and Advanced Materials Collaborative Innovation towards the Sustainable Development Goals*. Forthcoming Report. Cologny.

[25] Solvay. (2017). *Our objectives by 2025 for a sustainable chemistry*. Weblink (accessed 14 February 2018).

[26] Dow. (2015). *2015 Sustainability Goals: The Sustainable Chemistry Index*. The Dow Chemical Company, Midland.

In the downstream textile sector, the Zero Discharge of Hazardous Chemicals Programme, which includes a collaboration of a number of brands, value chain affiliates and associations, commits itself to support the "widespread implementation of sustainable chemistry across the textile and footwear industries".[27] In the retail sector, the multinational corporation Walmart launched the 'Walmart Commitment to Sustainable Chemistry' in 2013. As part of the policy, Walmart developed a set of sustainable chemistry principles, including pledges to encourage "full ingredient transparency", advance the development of chemicals that "preserve efficacy of function while reducing toxicity", and "reduce its consumables chemical footprint" via participation in the Chemical Footprint Project. 28

Furthermore, start-up companies are being created with the aim of advancing sustainable chemistry. On the occasion of the 'Sustainable Chemistry Conference: the way forward', held in 2015 in Berlin, Germany, entrepreneurs presented innovative scientific solutions with a potential to reduce, re-use and recycle expensive and harmful chemicals.[29] Initiatives are also underway in developing countries and economies in transition. the During the workshop on 'Advancing Entrepreneurship and Start-up Initiatives for Sustainable Chemistry: Learning from Case Studies', entrepreneurs from Brazil, India, South Africa, and Ghana shared their case examples.[30] Start-ups from developing countries have also been recognized at the Elsevier Foundation's yearly 'Green and Sustainable Chemistry Challenge'[31]. As another example, in 2014, an investment company from South Africa, partnered with the 'Sustainable Chemistry Alliance' and the 'Bio-industrial Innovation Centre' to advance the commercialization of life science and bio-industrial technologies.[32]

2.3 Public Sector

In 2014, SusChem, the European Technology Platform for Sustainable Chemistry, was launched as a European Union supported initiative in 2014 to revitalise and inspire European chemistry and industrial biotechnology research, development and innovation in a sustainable way. The European Union has also released a publication, which presents the objectives and main achievements of 18 selected projects funded under the 5th and 6th Framework Programmes in the fields of novel materials and sustainable chemistry.[33] Moreover, the International Sustainable Chemistry Collaborative Centre was launched in 2017 as an initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the German Environment Agency, which is also reflected in a voluntary commitment to beat pollution made by the Government of Germany at the third session of the United Nations Environment Assembly in December 2017.[34]

A recently published technology assessment on chemical innovation prepared by the United States (US) Government Accountability Office (GAO) explored "the opportunities, challenges, and federal roles in sustainable chemistry"[35]. Among others, the report investigates varying stakeholder definitions and

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[27] ZDHC. (2017). *Commitment to Sustainable Chemistry Strengthens with Six New Contributors Joining ZDHC*. Weblink (accessed 14 February 2018).

[28] Walmart. (2017). *Walmart Commitment to Sustainable Chemistry*. Weblink (accessed 14 February 2018).

[29] German Environment Agency. (2015). *Sustainable Chemistry Conference 2015*. Weblink (accessed 10 October 2018).

[30] UN Environment. (2017). *Advancing Entrepreneurship and Start-up initiatives for Sustainable Chemistry: Learning from Case Studies' (UN Environment*. Weblink (accessed 27.02.2018).

[31] Elsevier. (2018). Elsevier Foundation Green and Sustainable Chemistry Challenge. Weblink (accessed 12 october 2018).

[32] Sustainable Chemistry Alliance. (2011). Sustainable Chemistry Alliance, Bioindustrial Innovation Centre to Collaborate with South African Incubator on Commercialization. Weblink (accessed 27.02.2018).

[33] European Commission. (2008). Novel materials and sustainable chemistry – A decade of EU-funded research. ISBN 978-92-79-09721-8. Luxembourg: Office for Official Publications of the European Communities.

[34] ISC3. (2017). *International Sustainable Chemistry Collaborative Centre: Who we are*. Weblink (accessed 14 February 2018); UN Environment (2017). *Annex 2: #BeatPollution Voluntary Commitments from Governments*. United Nations Environment Programme, Nairobi.

[35] United States Government Accountability Office. (2018). *Chemical Innovation – Technologies to Make Processes and Products More Sustainable*. Weblink (accessed 12 October 2018).

assessments of sustainable chemistry, and discusses relevant technologies. The report finds that "stakeholders lack agreement on how to define sustainable chemistry and how to measure or assess the sustainability of chemical processes and products", noting that "these differences hinder the development and adoption of more sustainable chemistry technologies". The report also identified various themes that stakeholders and the literature associate with sustainable chemistry, including resource efficiency, reduction or elimination of the use or generation of hazardous substances, ensuring chemistry innovation contributes to all three dimensions of sustainable development and a life-cycle perspective. Also in 2018, the draft "Sustainable Chemistry Research and Development Act"[36] was introduced in the US Senate. The draft Act foresees among other a "Roadmap for Sustainable Chemistry", including the development of "a working framework of attributes characterizing sustainable chemistry".

In developing regions, the Government of Vietnam and the Government of Ghana, with support of the 'Deutsche Gesellschaft für Internationale Zusammenarbeit', hosted national workshops in 2017 to take stock of, and develop recommendations for action in the area of sustainable chemistry. The Governments of Ghana and Germany also joined forces, in cooperation with UN Environment and the Secretariat of the Basel, Rotterdam and Stockholm Conventions, to organize side events on sustainable chemistry at the second session of the United Nations Environment Assembly and during the 2017 Conferences of the Parties to the Basel, Rotterdam and Stockholm Conventions.[37]

2.4 Intergovernmental Organizations

In 1998, Member countries of the Organisation for Economic Co-operation and Development endorsed the implementation of an initiative on sustainable chemistry, with a focus on prevention as a means of transforming the chemicals sector.[38] The Organisation for Economic Co-operation and Development published several reports on sustainable chemistry, including on the 'Need for Research and Development Programmes in Sustainable Chemistry' and on 'Sustainable Chemistry: Evidence on Innovation from Patent Data'.[39] It is also implementing projects related to sustainable chemistry and has developed a definition of sustainable chemistry.[40] Moreover, it developed defined 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. Sustainable chemistry encompasses the design, manufacture and use of efficient, effective, safe and more environmentally benign chemical products and processes". The definition further notes that 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" and can provide various environmental and social benefits.

In 2017, the Organisation for the Prohibition of Chemical Weapons, in cooperation with the International Council of Chemical Associations and the International union of Pure and Applied Chemistry, organized the 'Green and Sustainable Chemistry Workshop' to develop recommendations for improving chemical

[36] United States Congress. *S.3296 – Sustainable Chemistry Research and Development Act of 2018*. Weblink (accessed 12 October 2018).
[37] BRS Secretariat. (2017). *2017 COPs Side events*. Weblink (accessed 14 February 2018).
[38] OECD. (1998). *Proceedings of The OECD Workshop on Sustainable Chemistry Part1*. ENV/JM/MONO(99)19/PART1. Organization for Economic Co-operation and Development, Paris.
[39] OECD. (2002). *Need for Research and Development Programmes in Sustainable Chemistry*. ENV/JM/MONO(2002)12. Organization for Economic Co-operation and Development, Paris.
[40] OECD. (2018). *Sustainable Chemistry*. Weblink (accessed 14 February 2018); OECD. (2012). *The Role of Government Policy in Supporting the Adoption of Green/Sustainable Chemistry Innovations*. ENV/JM/MONO(2012)3. Organization for Economic Co-operation and Development, Paris.

safety and security within industry.[41]

At the UN level, in addition to two side events organized at the margins of the second session of the United Nations Environment Assembly and the Conferences to the Parties of the Basel, Rotterdam and Stockholm Conventions in 2017, the 2018-2019 Programme of work of UN Environment, approved by governments at the second session of the United Nations Environment Assembly in May 2016, includes a project concept focusing on sustainable chemistry.[42] Initial work has commenced through a workshop in 2017 on ‘Advancing Entrepreneurship and Start-up Initiatives for Sustainable Chemistry: Learning from Case Studies’, organized in cooperation with and the United Nations Industrial Development Organization and the International Sustainable Chemistry Collaborative Centre.[43] UN Environment and the International Sustainable Chemistry Collaborative Centre also collaborated in the organization of a side event at the 23rd Conference of the Parties to the United Nations Framework Convention on Climate Change in 2017, focusing on the potential of sustainable chemistry in contributing towards climate action. The concept of sustainable chemistry was also highlighted in a speech held in 2017 by the Director-General of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) on the occasion of an award ceremony for research projects proposed by young scientists[44].

Sustainable chemistry is also among the topics discussed in the context of the intersessional process to prepare recommendations regarding the Strategic Approach and the sound management of chemicals and waste beyond 2020, initiated at the fourth session of the International Conference on Chemicals Management in 2015. Participants at the first meeting of the intersessional process, which took place in Brazil in February 2017, discussed sustainable chemistry both in an informal dialogue and during a plenary session.[45] A thought starter developed in early 2017 by the Bureau of the fifth International Conference on Chemicals Management informed these discussions through a section on “the role of sustainable chemistry”.[46] Moreover, the co-chair’s summary of the meeting listed sustainable chemistry among other elements that could be taken into consideration in considering the scope of a future platform for the sound management of chemicals and waste beyond 2020.[47]

[41] OPCW. (2017). *Experts Discuss Role of OPCW in Green and Sustainable Chemistry*. Weblink (accessed 27.02.2018).

[42] UN Environment. (2016). *UNEA Resolution 2/20. Proposed medium-term strategy for 2018–2021 and programme of work and budget for 2018–2019*. UNEP/EA.2/Res.20. United Nations Environment Programme, Nairobi.

[43] The event was organized in 2017 by UN Environment and the International Sustainable Chemistry Collaborative Centre (ISC3), in partnership with the United Nations Industrial Development Organization (UNIDO), the German Chemical Society, the Freie Universität Berlin and the United Nations institute for Training and Research (UNITAR). More information is available on the website of UN Environment

[44] UNESCO. (2017). *Address by Irina Bokova, Director General of UNESCO on the occasion of the PhosAgro/UNSCO/IUPAC Award-Giving Ceremony*. Weblink (accessed 12 October 2018).

[45] SAICM Secretariat. (2017). *Report of the first meeting in the intersessional process to consider the Strategic Approach and the sound management of chemicals and waste beyond 2020*. SAICM/IP.1/7. SAICM Secretariat, Geneva.

[46] SAICM Secretariat. (2017). *Thought starter for the first meeting of the intersessional process*. SAICM/IP.1/4*. SAICM Secretariat, Geneva.

[47] SAICM Secretariat. (2017). *Co-chairs’ summary of the discussions during the first meeting of the intersessional process to consider the Strategic Approach and the sound management of chemicals and waste beyond 2020*. SAICM Secretariat, Geneva.

2. Analysis of Stakeholder Submissions

3.1 Data Collection and Stakeholder Responses

To facilitate input responding to the invitation in Resolution 2/7 for stakeholders having relevant experience with the issue of sustainable chemistry to submit best practices, indicating how these may enhance the sound management of chemicals, inter alia through the implementation of the 2030 Agenda for Sustainable Development, as well as the Strategic Approach to International Chemicals Management and chemicals- and waste-related multilateral environmental agreements, UN Environment sent an invitation to stakeholders of the Strategic Approach to International Chemicals Management in May 2017, focal points of the Basel, Rotterdam and Stockholm Conventions, and focal points of the Minamata Convention, including a request to disseminate the invitation to relevant stakeholders.[48] The initial deadline of 30 June 2017 was extended until 30 November 2017. For each case, respondents were requested to briefly introduce the environmental/health context and challenge; describe the case, its benefits and how it contributes to sound management of chemicals and implementation of the SDG; and conclude with lessons learned and future opportunities, if relevant.

In total, 38 stakeholders responded, providing 80 cases (some responses included several cases).[49] Annex A provides an overview of the institutions/organisations that made submissions. Annex B provides a list of the submitted cases, including a brief summary and the entities undertaking them. The 38 responses originated from a variety of stakeholders. Most responses came from the private sector (ca. 37 %; 14 responses), followed by civil society (ca. 21 %; 8 responses); academia (ca. 18%; 7 responses); the public sector (ca. 18%; 7 responses, including 5 from developing countries and countries with economies in transition); and intergovernmental organizations (ca. 5 %; 2 responses).[50] All five UN regions were represented, with nearly two-thirds of the responses from the Western European and Others Region, followed by the Asia-Pacific Region and the African Region. In total, 11 responses came from developing countries or countries with economies in transition. In a number of cases, the respondents submitted cases undertaken by other stakeholders. As shown in Figure 3.1, the largest share of the 80 cases is undertaken by the private sector.

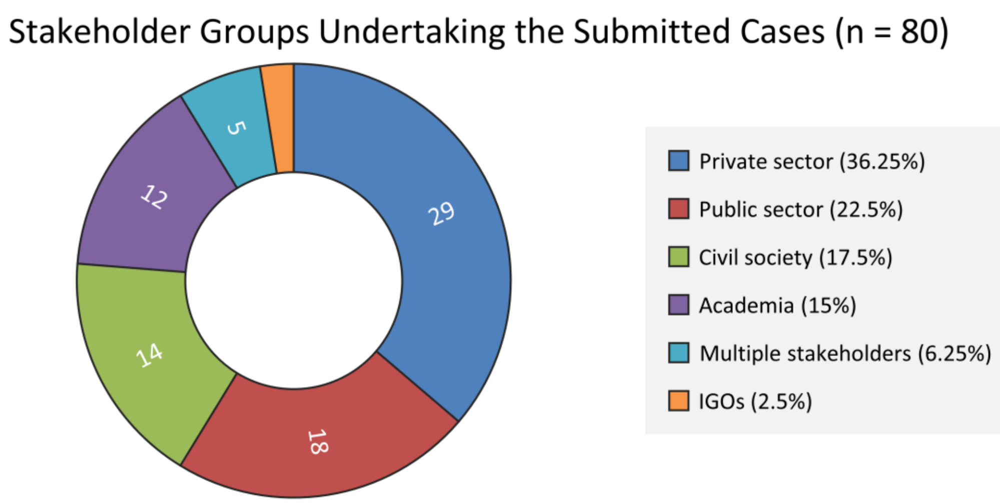

Figure 2.1: Stakeholder Groups Undertaking the Submitted Cases (n = 80)

[48] The online form can be accessed via this weblink.

[49] Some responses had to be removed as they were incomplete and/or did not contain any substantive input (i.e. in total there were more than 38 responses). In these cases, and if contact details were provided, the secretariat followed up with the respondents.

[50] Full submissions are available on request.

3.2 Linkages to the 2030 Agenda, SAICM and the Chemicals- and Waste-related MEAs

Throughout the cases, which ranged from technological interventions to institutional arrangements, numerous indications were provided outlining how the cases contribute to the implementation of the 2030 Agenda for Sustainable Development, the sound management of chemicals and waste, SAICM and the MEAs. An analysis was undertaken in order to identify the number of cases contributing to each of these concepts/agreements. In cases where terminology was used that is similar thought not identical to the listed concepts/agreements but clearly refers to them, these were included in the respective count[51]. Some of the 80 cases referred to several of the concepts/agreements, while others referred to none of them.

The results are shown in Figure 3.2. Most common (ca. 39% of cases) were references to the 2030 Agenda, the SDG at large and/or specific SDG and Targets. Also widespread (ca. 30% of cases) were references to the sound management of chemicals and waste or similar terminology[52]. A considerable number of cases (ca. 18%) highlighted how they may contribute to the implementation of SAICM. A number of cases (ca. 11 %) explored linkages to the chemicals and waste-related MEAs, with the Stockholm Convention being the most widely mentioned.

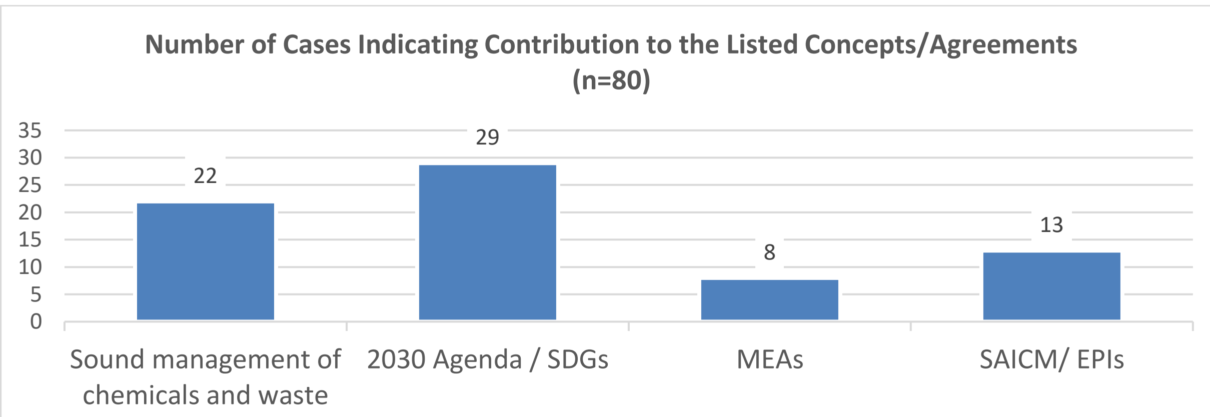

Figure 2.2: Number of Cases Indicating Contribution to the Listed Concepts/Agreements (n=80) (notes: some cases referred to several of the concepts/agreements; some cases referred to none; terminology similar to the listed concepts/agreements but clearly referring to them was included in the count)

Exploring in more detail the references made to specific SDG, Figure 3.3 shows how many cases explicitly referred to which SDG, including Targets under that SDG. The most widely referred to Goal was SDG 12 on Sustainable Consumption and Production (mentioned in 18 cases). 13 cases mentioned each of the SDG 3 on Good Health and Well-being, SDG 6 on Clean Water and Sanitation, SDG 8 on Decent Work and Economic Growth, SDG 9 on Industry, innovation and Infrastructure, and SDG 11 on Sustainable Cities and Communities. The most widely quoted Target was Target 12.4.

[51] E.g.: sound chemicals management and SMCW were included under ‘sound management of chemicals and waste’; UN Goals and Sustainability Goals were included under ‘2030 Agenda / SDG’ etc.

[52] E.g. sound chemicals management, SMCW etc.

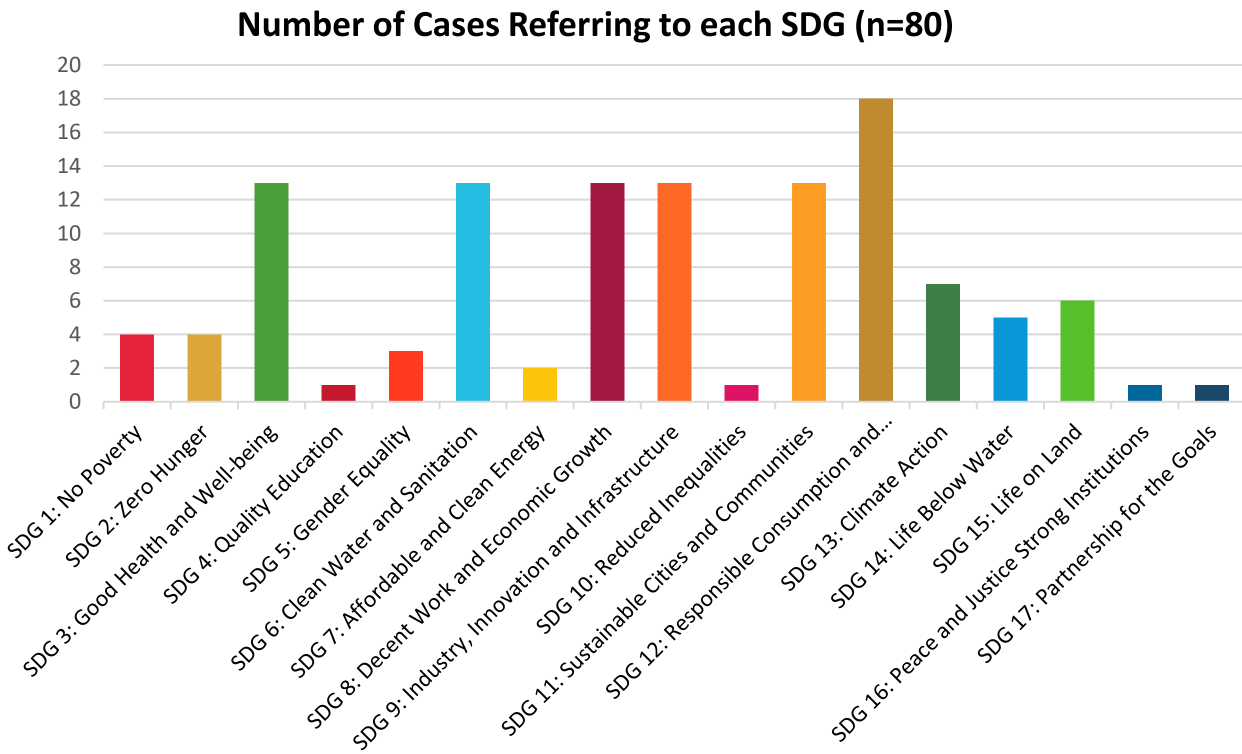

Figure 2.3: Number of Cases Referring to each SDG (n=80) (note: references to targets were included under the respective SDG)

A number of cases outline how they contribute to achieving various SDG and Targets simultaneously[53]. Meanwhile, none of the cases discussed potential trade-offs across SDG/Targets, i.e. situations where the contribution towards one of the SDG/Targets may come at the expense of progress towards another SDG/Target.

One respondent used an assessment scheme to systematically evaluate cases by judging the extent to which they address aspects related to green chemistry, the sound management of chemicals and waste, and sustainable chemistry (considering characteristics related to ecological, economic and social goals of sustainable chemistry) as well as connections to the 2030 Agenda. This approach is consistent with a holistic interpretation of the sustainable chemistry concept.

3.3 Contribution to SDG Target 12.4

Throughout many of the submitted cases, reference was made how they enhance specific aspects of the sound management of chemicals and waste, in line with SDG Target 12.4, and the related implementation of the chemicals and waste multilateral environmental agreements and the Strategic Approach to International Chemicals Management.[54] In addition, other elements addressed by SDG 12 on Sustainable Consumption and Production, such as resource efficiency were also covered. In analysing the cases, a number of common themes emerged, addressing all stages of the life cycle. These are noted below, including illustrative examples.

[53] See for example case 'UNIDO's Global Chemical Leasing Programme'

[54] For the five objectives and the eleven basic elements, see: SAICM Secretariat. (2006). *SAICM texts and resolutions of the International Conference on Chemicals Management*. United Nations Environment Programme, Geneva.

Substituting and reducing use of chemicals of concern

A number of cases address the substitution and/or reduction of use of chemicals of concern. In this context, including at the international level (for example in Resolution 2/7 adopted by UNEA), reference is made to “non-chemical alternatives”. This term has been used in various ways, for example to refer to reduction of the use of chemicals of concern by relying on biological processes, process change and the use of approaches such as agroecology. Submissions referring to such approaches suggest that stakeholders consider the concept of sustainable chemistry to go beyond the focus on chemistry in scientific sense as a scientific discipline. Stakeholders have highlighted the need to scale up support and promote such alternatives as a means of preventing the use of chemicals of concern. The below mentioned submissions aim, among others, to protect human health and the environment, reduce water and energy consumption, minimise use of chemicals of concern, and increase use renewable feedstocks and biological processes, while also reducing costs, increasing efficiencies and improving performance.

Some of the cases focus on substitution or reduction in the *production process of chemicals.* For example, cases describe the use of an altered surfactant technology in the production of pharmaceuticals[55], reliance on bioconversion in the production of ethylene56, and replacement of neurotoxic chemicals in the production of pharmaceuticals[57]. Other cases address the substitution of chemicals with safer chemicals in *other industrial production processes*. These include the replacement of a solvent in the production of industrial labels, use of alternatives in the treatment of process cooling water[58], and the utilization of steel slag to replace strong- and amine-based reagents, for example in CO2 sequestration.59 Several cases address the replacement of chemicals with safer chemicals in a range of *products*, for instance in dishwasher tabs, cans, and flame retardants in insulation foam.60 One case describes the use of biomass for the manufacture of ink.61 Contributing to the implementation of the Minamata Convention on Mercury and the Stockholm Convention on Persistent Organic Pollutants, two cases focus on the *replacement of equipment* with alternatives that do not require the use of mercury and polychlorinated biphenyls, respectively.62 Cases also address the replacement of chemicals via reliance on alternative *management approaches*, for example through agroecology.[63]

Efficient and environmentally sound use & reduction of emissions and exposure

Some cases focus on environmentally sound and efficient use of chemicals and minimizing of chemical emissions and releases in production processes, for example by reducing the use of solvents.[64] Chemical leasing, promoted among others by the United Nations Industrial Development Organization (UNIDO) in collaboration with its partners, is featured in several cases as an innovative tool, for example for gluing of boxes and for cleaning operations in the automotive sector and hotels.[65] Another example describes

[55] Case ‘Removing organic solvents from our processes’

[56] Case ‘Bioconversion of crude glycerol to ethylene

[57] Case ‘Replacement of chemicals of concern used in the production of pharmaceuticals’

[58] Case ‘Chemical Substitution – Corrosion Inhibitors’

[59] Cases ‘Kilian – Functional Substitution’; and ‘Utilization of steel slag as a multi-purpose sorbent for pollutants’

[60] Cases ‘BASF-Trilon M’; ‘CANVERA™ Polyolefin Dispersion for Can Coatings’; ‘BLUEDGE™ Polymeric Flame Retardant Technology’; and ‘ChemSec Marketplace’

[61] Case ‘Prometho GmbH – GrüneTinte’

[62] Cases ‘Banning of Import; Purchase and Uses of all mercury based equipment's in health sector of Nepal’; and ‘Promoting PCB Free Metal Fabrication through Technology Transfer’.

[63] Case ‘Replacing Chemicals With Biology: Phasing out Highly Hazardous Pesticides with Agroecology’

[64] For example cases ‘PERO & SAFECHEM – Cleaning of metal parts’; ‘Kilian – Functional substitution’; and ‘Prometho GmbH – GrüneTinte’.

[65] Two cases entitled ‘Chemical Leasing’; case ‘The German Chemical Leasing Case’; cases ‘Chemical Leasing in automotive parts industry’; and ‘Chemical Leasing in Hotels’

the introduction of chemical leasing in a hospital to reduce the use of disinfectants.[66] Examples also cover regulatory cases and development of national action plans aiming to reduce the consumption of chemicals, for instance to minimize the use of biocides and plant protection products.[67] One case provides a tool for benchmarking companies in the selection of safer alternatives and the reduction of their use of chemicals of high concern.[68]

Other cases focus in particular on reducing exposure of vulnerable groups, for example to protect students from lead in paint and children from heavy metals contained in toys or to reduce the exposure of workers to asbestos.[69] Others seek to minimize risks and adverse impacts by ensuring the environmentally sound handling of chemicals of concern, for example via implementation of the Globally Harmonized System of Classification and Labelling (which is not yet operational in more than 120 countries), improved tracking in the transport of hazardous materials, and safe use of plant protection products.[70]

Waste management, recycling and remediation of pollution

Examples of cases focusing on recycling/re-use include a pilot plant for polymer recycling, further development of the power to gas technology for carbon capture and utilization, and production of carbon black from non-volatile residues of the petrochemical industry.[71] Other cases address waste management and offer end-of-the-pipe solutions to remediate pollution. Examples range from a project to reduce the burning of medical waste, over the introduction of a three-stage wastewater treatment process to separate nitrates from wastewater, to the use of a biocatalyst for the clean-up of oil spills.[72]

Cross-cutting and enabling topics

In addition to focusing on specific chemical management themes relating to various aspects of the life cycle, some cases cut across the life cycle. Examples include the establishment of an international centre to advance sustainable chemistry and a voluntary chemical industry initiative to build capacity for sound chemicals management.[73] Other cases seek to advance a circular economy by addressing the entire value chain. Examples include a tool implemented by major corporations to identify hazardous chemicals and alternatives, which can also be used to guide procurement, product design, standards and policies, a project measuring and disclosing data on business progress to safer chemicals, and the application of green chemistry across supply chains by developing and promoting relevant tools, policies and business practices and by fostering collaboration among relevant stakeholders.[74][75]

Many of the cases also seek to establish an enabling environment in order to address several or all of the aspects of the life cycle. These include, but are not limited to, innovative business models (e.g. chemical leasing); assessment frameworks and guidance; regulatory measures and governance; awareness-raising

[66] Cases ‘chemical leasing – efficient and sustainable hospital hygiene’

[67] Cases ‘5-point Programme for Sustainable Plant Protection’; and ‘Biocides – Proposal for a Concerted European Approach towards a Sustainable Use’.

[68] Cases entitled ‘Chemical Footprint Project’

[69] Cases ‘Research based campaign for Mandatory Lead Paint Standard in Nepal’; ‘Campaign for Standard of Children Toys’; and ‘Banning of Import, Sale, Distribution and Uses of Asbestos in Nepal’.

[70] Cases ‘Capacity Building to Foster the Sound Management of Chemicals’; and National Action Plan on Sustainable Use of Plant Protection Products’.

[71] Cases ‘3M – Recycling of PTFE’, ‘Audi – Power to Gas’; and ‘Waste Heat Recovery’.

[72] Cases ‘Elimination of POPs and its Sources in Nepal’; ‘Süd-Chemie: Waste Water Treatment’; and ‘EcoBioClean Solves a Global Problem’.

[73] Cases ‘The International Sustainable Chemistry Collaborative Centre (ISC3)’; and ‘Capacity Building to Foster the Sound Management of Chemicals’.

[74] Case ‘Green Chemistry and Commerce Council’

[75] Cases ‘GreenScreen’ ; and ‘Chemical Footprint Project’

and advocacy campaigns; capacity building, technology transfer and education; and knowledge and information.

3.4 Contribution to Other SDG in the 2030 Agenda

Many cases explicitly address other SDG and Targets in addition to the 12.4 Target, presenting opportunities how sustainable chemistry contributes to the achievement of the 2030 Agenda across a broader spectrum of SDG and Targets. A number of examples for various SDG are described below. The initial analysis presented here is based on the descriptions provided by the stakeholders and does not imply a judgement as regards their impact and whether the practices may or may not be fully compatible with sustainable development. For example, potential trade-offs may exist in some areas (e.g. if increased use of biomass feedstocks results in increased pressure on soils or deforestation).

Sustainable Development Goal 1: No Poverty

Several cases note contributions to improve living standards, income and access to resources of the poor and vulnerable. For example, one case explains how the establishment of equitable agricultural systems can help to empower farmers and local communities by reducing debt and providing livelihood opportunities.[76]

Sustainable Development Goal 2: Zero Hunger

One case describes how ecosystem-based approaches to pesticide and crop management can help to phase out highly hazardous pesticides, while at the same time increasing food security and providing access to safe and nutritious food.[77] Other cases explore integrated approaches for sustainable plant protection and sustainable use of plant protection products where they are necessary to ensure sufficient food production.[78]

Sustainable Development Goal 3: Good Health and Well-being

Examples of cases with links to the protection of human health, including vulnerable groups, and reference to the achievement of SDG 3 include an awareness-raising campaign to ban equipment containing mercury from the health sector and the use of chemical leasing to reduce the use of hazardous chemicals and protect workers during industrial cleaning in the automotive sector.[79]

Sustainable Development Goal 5: Gender Equality

Contribution to gender equality features prominently in a case describing how in the context of a cooperation between a chemical company and a cooperative network, a large number of women were engaged, improving their economic and social standing.[80]

Sustainable Development Goal 6: Clean Water and Sanitation

Cases seeking to contribute to SDG 6 include the introduction of a wastewater treatment process allowing improved removal of heavy metal nitrates, and optimization of the process for the production

[76] Case 'Replacing Chemicals With Biology: Phasing out Highly Hazardous Pesticides with Agroecology'

[77] Case 'Replacing Chemicals With Biology: Phasing out Highly Hazardous Pesticides with Agroecology'

[78] Cases 'National Action Plan on Sustainable Use of Plant Protection Products' and '5-point programme for sustainable plant protection'

[79] Cases 'Banning of Import, Purchase and Uses of all mercury based equipment's in health sector of Nepal'; and 'PERO & SAFECHEM – Cleaning of metal parts'.

[80] Cases 'BASF – Argan program in Morocco'.

of carbon black via waste heat recovery, water recycling and the minimization of odour pollution.[81]

Sustainable Development Goal 7: Affordable and Clean Energy

One case describes how improved energy efficiency was achieved via the introduction of an innovative bio-catalytic reaction.[82] Another case deals with carbon capture and utilization in the automotive sector, explaining how an improved power to gas technology would allow the greenhouse gas-neutral operation of cars.[83]

Sustainable Development Goal 8: Decent Work and Economic Growth

The protection of workers' health and safety figures prominently in a number of cases, including an awareness-raising campaign targeting the phase out of asbestos use and the development of a pilot plant for polymer recycling.[84]

Sustainable Development Goal 9: Industry, Innovation and Infrastructure

By focusing on research and development, innovation and the establishment of infrastructures for sound chemicals management, most of the cases contribute to the achievement of SDG 9. Some place particular emphasis on these aspects, including the introduction of new technologies, the establishment of pilot plants, and the introduction of novel business models.[85]

Sustainable Development Goal 10: Reduced Inequalities

One of the cases describes a fair-trade agreement between a chemical company and a cooperative network for the production of Argan oil, which allowed the cooperative to grow significantly and sell its product at fixed premium rates, with shares of the profit used to finance literacy programs and health cases.[86]

Sustainable Development Goal 11: Sustainable Cities and Communities:

Several cases were framed as contributing to the provision of safe housing. For example, one case presents action to promote the construction of 'green' buildings by promoting the use of building materials and products that are certified according to meet specified environmental standards.[87] Another case describes the development of a grow tile for improved binding of the soil, providing increased opportunities for green spaces in urban districts.[88] Two cases explicitly address the importance of flame retardants for safe housing, both via the use of an assessment tool for safer flame retardants and via the introduction of alternative technologies.[89]

[81] Cases 'Süd-Chemie: Waste Water Treatment'; and 'Waste Heat Recovery'.
[82] Case 'Green and sustainable technologies to develop a greener and more energy efficient process to manufacture Pregabalin, active ingredient in the drug Lyrica'.
[83] Case 'Audi – Power to Gas (PtG)'.
[84] Cases '3M – Recycling of PTFE'; and 'Banning of Import, Sale, Distribution and Uses of Asbestos in Nepal'.
[85] For example, the cases 'Audi – Power to Gas, 3M – Recycling of PTFE'; 'Removing organic solvents from our processes, Süd-Chemie: Waste Water Treatment'; and 'Chemistry for Green Building; the German Chemical Leasing Initiative, Chemical Leasing, Chemical Leasing in automotive parts industry'.
[86] Case 'BASF – Argan program in Morocco'.
[87] Case 'Chemistry for Green Building'.
[88] Case 'Dow HYPOL Binder For Improving Technology In A Sustainable Manner'
[89] Case 'SAFR®: Integrating exposure with hazard in a new assessment approach for responsible flame retardant solutions'; and 'BLUEDGE™ Polymeric Flame Retardant Technology'.

Sustainable Development Goal 12: Responsible Consumption and Production

Contributions to sustainable consumption and production in addition to Target 12.4 are also covered in a number of cases. For example, several cases emphasise their contribution to Target 12.2 on the efficient use of natural resources, including via transformation of the feedstocks in chemical industry from fossil to regenerative raw materials and methane synthesis for fuelling cars with gas engines.[90] Other cases note contributions to Target 12.6 by encouraging companies to adopt sustainable practices and integrating sustainability information into their reporting cycle.[91]

Sustainable Development Goal 13: Climate Action

Examples of cases addressing SDG 13 addressing climate change include reduction of energy use in cracking in oil refining[92], the use of sustainable chemistry to improve industrial processes to reduce energy consumption and emissions of greenhouse gases.[93] Another case addresses the introduction of renewable feedstocks to replace fossil fuels as front-of-the-pipe intervention in integrated production systems.[94] The cases also feature the use of sustainable chemistry for carbon capture, in the automotive sector, and in the production of polymers.[95]

3.5 Inputs on the Sustainably Chemistry Concept by Stakeholders

Several stakeholder responses provided complementary views regarding the sustainable chemistry concept. Several of them tend and propose to frame the sustainable chemistry concept in a broad and holistic manner.

A submission by an NGO notes that “at its best, sustainable chemistry could shift the entire industry to safer production and improve environmental protection, consumer safety and occupational health and safety by eliminating hazards.” The submission clarifies that this would require defining sustainable chemistry as including reduction and elimination of hazards of chemicals throughout the life cycle as a priority, including through agroecology. The submission explains that sustainable chemistry attempts to “expand conventional chemistry to include environmental, social and economic aspects”.[96]

Along similar lines, a government submission puts forward a wide-ranging understanding of the sustainable chemistry concept. What qualifies as sustainable chemistry could be assessed based on a set of criteria that address all three dimensions of sustainable development (climate footprint, impacts on the environment, product design, risks to health, economic benefits, transparency, social standards, dialogue and international cooperation, etc.). These indicators are proposed primarily for the purpose of assessing products and processes.[97]

A submission by an industry association, referring to the outcomes of a multi-stakeholder workshop, reiterates the need to consider all three dimensions of sustainable development in exploring the contribution of chemistry to sustainable development. The submission also emphasises the continuing

[90] Cases ‘Covestro – Dream Production’; and ‘Audi-Power to Gas (PtG).
[91] For instance the cases ‘Chemical Footprint Project’; and ‘Green Chemistry and Commerce Council’
[92] Case ‘Climate Change Mitigation’
[93] See for example the cases ‘CANVERA™ Polyolefin Dispersion for Can Coatings; Waste Heat Recovery’; and ‘PERO & SAFECHEM – Cleaning of metal parts’
[94] Cases ‘Biomass Balance approach – A groundbreaking way of using renewable resources in production’
[95] Cases ‘Audi – Power to Gas (PtG)’ and ‘Covestro – Dream Production’.
[96] Case ‘Comments on Green Chemistry and Sustainable Chemistry in Response to Resolution 2/7 of the UN Environment Assembly’.
[97] Case ‘Parameters of Sustainable Chemistry’.

importance of a basic national regulatory infrastructure and availability of information.[98]

A submission by the International Union of Pure and Applied Chemistry (IUPAC) and the Interdivisional Committee on Green Chemistry for Sustainable Development (ICGCSD) discusses the relationship between the concepts of green chemistry and sustainable chemistry, noting that while the terms are often used interchangeably, they may have different meanings in different countries and contexts. The institution notes that green chemistry and sustainable chemistry are not in contrast with each other and emphasises the need to focus on practical applications of both concepts.

[98] Case 'Convening Diverse Stakeholders on Chemistry in Sustainable Development'

3. Survey on the Sustainable Chemistry Concept

4.1 Data Collection and Stakeholder Responses

In order to better understand stakeholder perceptions of the sustainable chemistry concept globally, UN Environment administered a survey in 2017 under the title: 'UN Environment Survey to Elicit Feedback on the Sustainable Chemistry Concept'. The purpose was to review perspectives, priorities, opportunities and challenges related to sustainable chemistry as seen by stakeholders from the public sector, the private sector and civil society, and to inform a dialogue what sustainable chemistry could mean in a global context.

UN Environment invited stakeholders of the Strategic Approach to International Chemicals Management, focal points of the Basel, Rotterdam and Stockholm Conventions, focal points of the Minamata Convention, as well as other internal and external partners to participate in the survey in May 2017. The initial deadline for submissions was set at 30 June 2017 and extended until 30 November 2017.[99]

The survey received a total of 63 responses. Respondents represented all UN regions (see Figure 4.1). It is worth noting that approximately two thirds of respondents were governments or other stakeholders from developing countries or countries with economies in transition. Responses were received from a variety of stakeholders. As can be seen in Figure 4.2, most responses came from academia. 62 % of respondents were female and 38 % male.

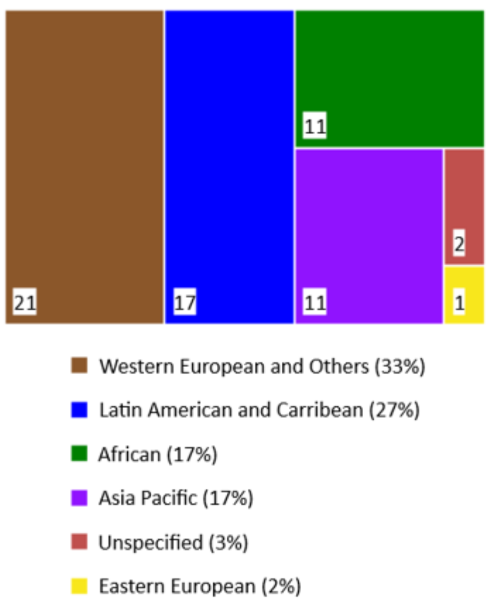

Figure 3.1 Responses by region from different stakeholders (n = 63, rounded percentages)

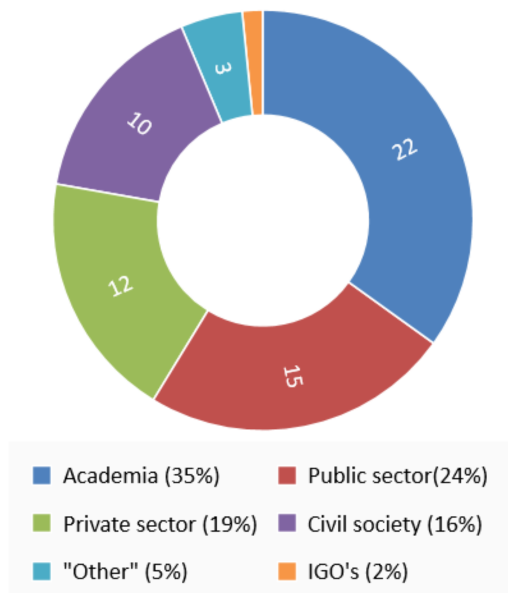

Figure 3.2: Responses by stakeholder groups (n = 63, rounded percentages)

[99] The online form used for the survey can be accessed via this weblink.

4.2 Stakeholder Perspectives on the Sustainable Chemistry Concept

Perspectives on sustainable chemistry in an international context

A large majority (89 % agreement)[100] of respondents felt that sustainable chemistry is an important component relevant for in advancing chemicals and waste management beyond 2020. Asked more specifically concerning three possible perspectives on how the sustainable chemsity concept could contribute in using the concept internationally, all three of the following proposed interpretations were supported (see Figure 4.3). The idea to use sustainable chemistry as an *assessment framework* for evaluating the contributions of chemicals to the SDG received the strongest support (93 % agreement). The perspective that sustainable chemistry is a *new type of chemistry* which is compatible with the three dimensions of sustainable development also received very strong support (88 % agreement). The third option – sustainable chemistry as a *destiny and benchmark* – was seen less favourably, althought participants also supported it (74 % agreement).

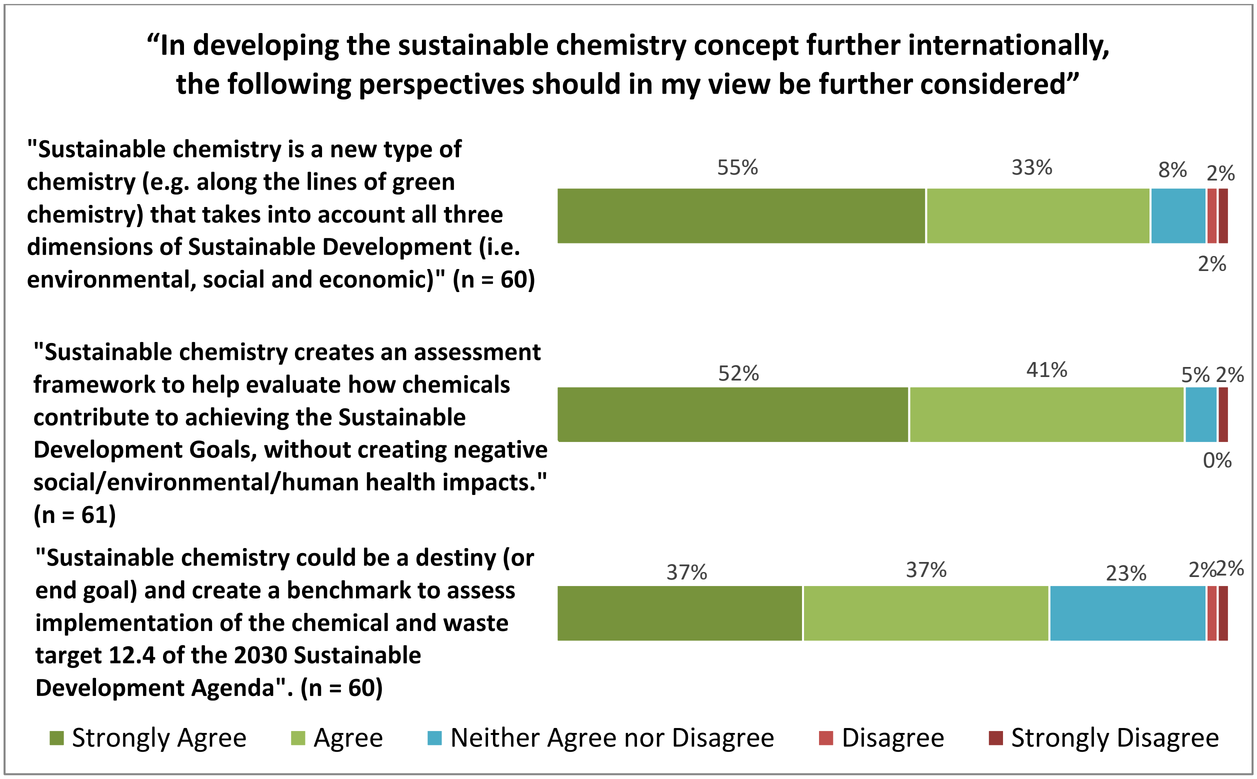

Figure 3.3: Sustainable chemistry in an international context (1) (rounded percentages)

The majority of respondends felt that an international definition of sustainable chemistry would be valuable (see Figure 4.4) and suggested an interest to develop the concept further internationally. Concerning a possible defition, results suggest a slightly higher preference for a detailed international definition compared to a simple one (72 % vs. 67 % agreement). In considering a simple definition, the large majority of participants (79 % agreement) supported a suggested option to frame it along the Brundlandt Commission's definition of sustainable development as follows: "Sustainable chemistry is the design, production, use, recycling and disposal of chemicals to support implementation of the 2030 Agenda for Sustainable Development and meeting the needs of the present, without compromising the

[100] 61 respondents answered this question, i.e. 2 participants abstained

ability of future generations to meet their own needs".[101] A number of written comments provided by participants also support this finding, i.e. to keep the definition as simple as possible. Other written comments recommended to refrain from the attempt to define sustainable chemistry, with some suggesting to focus on addressing concrete areas and examples instead.

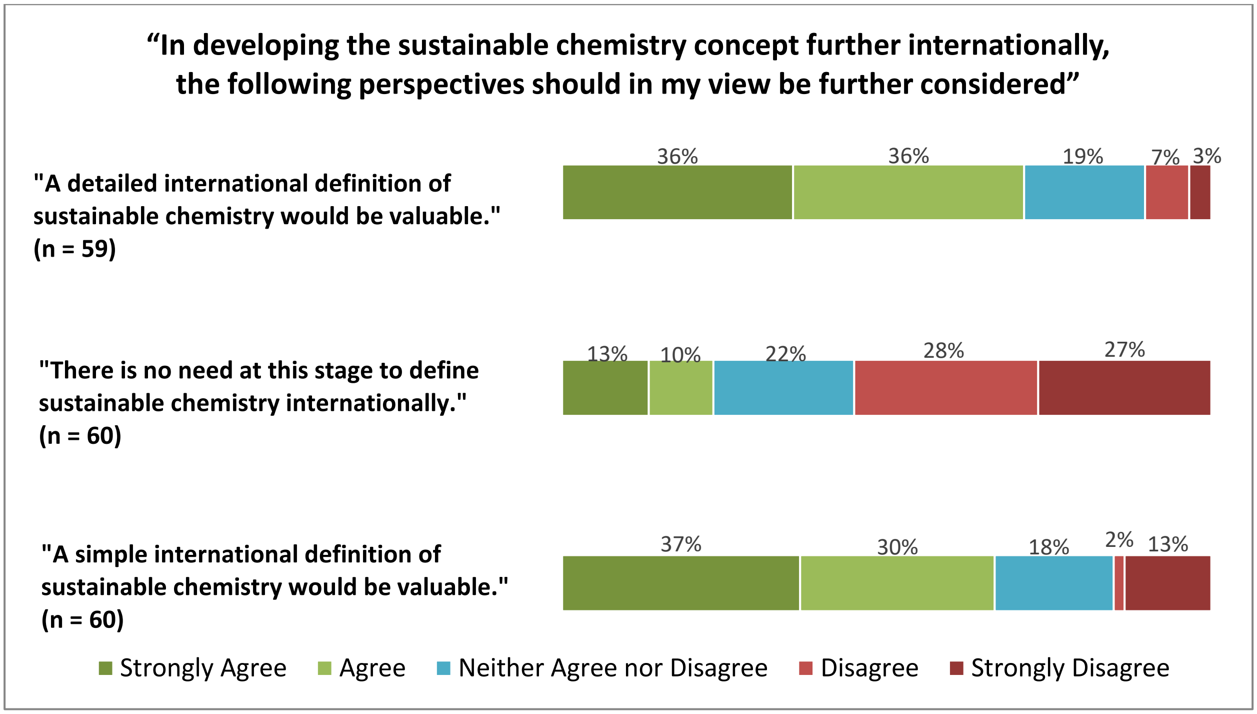

Figure 3.4: Sustainable chemistry in an international context (2) (rounded percentages)

Perspectives on topics covered by sustainable chemistry

The results of the survey indicate that a large majority of respondents strongly agreed or agreed that the sustainable chemistry concept encompasses the following:

- Identification and assessment of chemical and non-chemical alternatives for chemicals of concern (95 % agreement)
- Traditional chemical management tools, such as chemical hazard assessment, risk assessment and risk management (95 % agreement)
- Advancing technology transfer for safe chemicals and non-chemical alternatives (95 % agreement)
- Scaling up innovation through universities, start-up companies, and the chemical industry (91 % agreement)
- Reforming chemistry curricula to integrate green chemistry and sustainable development (90 % agreement)
- Use of economic instruments and innovative financing to advance innovation (82 % agreement)

Additional written comments confirm that participants favour a broad understanding of the sustainable chemistry concept. Through these comments, additional topics, such as the circular economy, life cycle

[101] This suggested option is in line with a reference to sustainable chemistry suggestion quote in the European Union publication on 'Novel materials and sustainable chemistry' (p. 4) (European Commission. (2008). *Novel materials and sustainable chemistry – A decade of EU-funded research*. ISBN 978-92-79-09721-8. Luxembourg: Office for Official Publications of the European Communities.

assessment and resource efficiency, were also proposed. Several respondents also suggested that sustainable chemistry encompasses all stages of the life cycle and cuts across the entire value chain.

Perspectives on *Sustainable Chemistry in a Developing Country Context*

The survey results indicate that participants from developed countries as well as from developing countries and economies in transition see sustainable chemistry as holding a potential for developing countries, as shown in Figure 4.5: A large majority of respondents supported the statement that sustainable chemistry creates an opportunity for leapfrogging chemicals management and technologies (81 % agreement in total; 90 % agreement among developed country respondents and 77 % agreement among respondents from developing countries and economies in transition). A large majority also supported the statement that technical assistance and technology transfer is important to advance sustainable chemistry in developing countries (88 % agreement). When distinguishing between responses from developed and developing countries, there was 95 % agreement among developed country respondents and 87 % agreement among respondents from developing countries and economies in transition. Stakeholders also specified some areas considered of importance in advancing sustainable chemistry in a developing country context, for example integration of green chemistry and sustainable chemistry in relevant curricula and use of the Organisation for Economic Co-operation and Development's Substitution and Alternatives Assessment Toolbox.

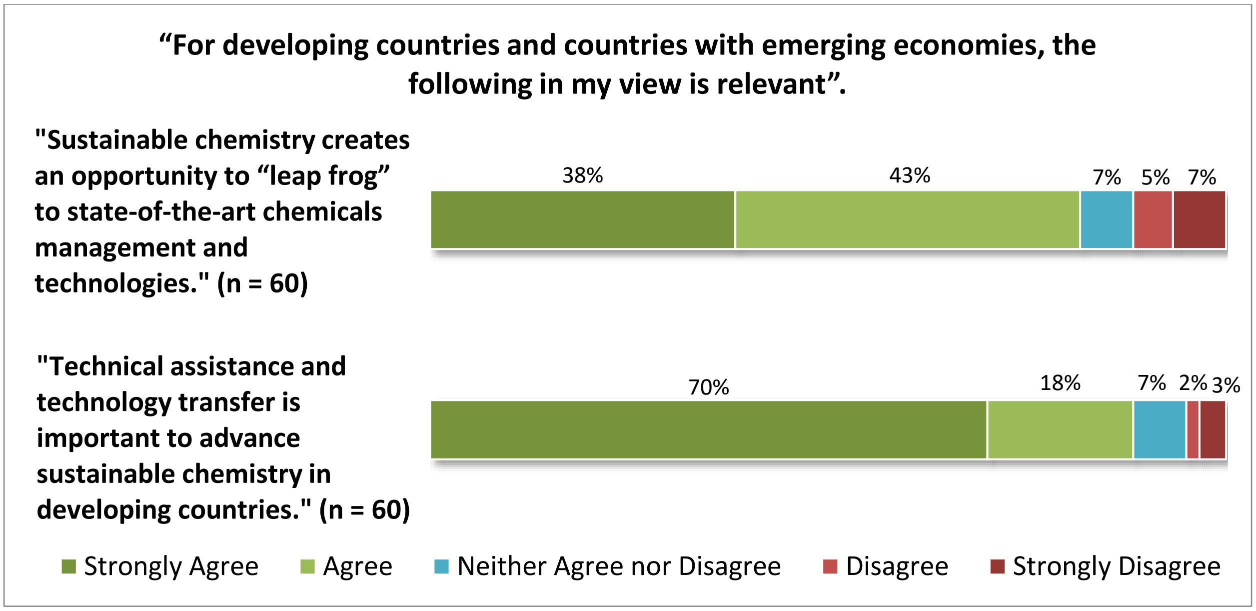

Figure 3.5:Sustainable chemistry in a developing country context (rounded percentages)

4. Summary Analysis

The preceding discussion suggests that sustainable chemistry is gaining momentum around the world and at the global level. However, since the concept is not a scientific term (unlike for example organic chemistry), its meaning is socially constructed, as also in the case of the concept of green chemistry. The exact nature of sustainable chemistry, what it entails and how it can contribute therefore needs further elaboration. In this context, the following considerations emerge from the analysis of stakeholder submissions in response to Resolution 2/7 adopted at the second session of the United Nations Environment Assembly and the UN Environment survey:

- Stakeholders see sustainable chemistry as playing a key role in achieving the SDG Target 12.4 on the sound management of chemicals and wastes, including implementation of the Strategic Approach to International Chemicals Management and the chemicals and waste multilateral environmental agreements, and other related aspects of SDG 12 on sustainable consumption and production. The submitted cases address all stages of the life cycle, including chemical and non-chemical alternatives; efficient and safe use and reduction of emissions and exposure; and waste management, recycling and remediation of pollution, thus highlighting potential synergies between chemicals and waste and resource efficiency.
- At the same time, the concept also helps to examine, and focus in more detail on the contribution of chemistry in achieving the broader 2030 Agenda SDG and Targets, such as zero hunger, climate action, safe housing, workers' health, innovation, and gender equality, while addressing all three dimensions of sustainable development.
- Stakeholder submissions and perspectives indicate that capacity-building and the establishment of an enabling environment are seen as important elements related to sustainable chemistry. Moreover, the concept is considered to hold potential for developing countries. Further work could explore how developing countries could be supported in potential future initiatives to advance sustainable chemistry, including through capacity-building, technology transfer and mobilisation of resources, thereby also relying on the use of existing tools.
- Given the interest of a large majority of stakeholders in the concept of sustainable chemistry, a practical starting point could be to develop a better understanding of sustainable chemistry opportunities globally, including possible development of a practical guidance on sustainable chemistry.
- A practical guidance could help to identify areas of action and innovations in chemistry that contribute to achieving the SDG without creating negative social, environmental, and health impacts. It could also help in a more systematic identification of best practices of sustainable chemistry in the future.
- Advancing the concept sustainable chemistry as a new type of chemistry is also an option, but this could be challenging, given the existence of the established green chemistry approach which is well-defined. Green chemistry could, however, become an important component of a broader approach to sustainable chemistry.
- Similarly, the perspective that sustainable chemistry is further developed internationally to serve as a destiny or end goal is an option. However, given the already widespread use of the sustainable chemistry term to characterise initiatives and action, further careful reflection would be needed how the option of sustainable chemistry being a destiny could be integrated into ongoing international discussions to develop a vision for chemicals and waste management beyond 2020.

Annex A: Overview of Responding Entities

#	**Institution/organisation**
Public Sector	
1	Agricultural Research Council, South Africa
2	Environment Ministry, Austria
3	Environment Protection Authority (EPA), Yemen
4	Federal Environment Agency, Germany
5	Tema Oil Refinery (TOR) Ltd.
6	The Permanent Mission of Mexico, Mexico
7	The Supreme Council for Environment, Bahrain
Intergovernmental organizations	
8	The Organisation for Economic Co-operation and Development (OECD)
9	The United Nations Industrial Development Organization (UNIDO)
Private sector	
10	American Chemistry Council (ACC)
11	Amoéba SA
12	BASF SE
13	European Automobile Manufacturers' Association (ACEA)
14	Foi Science (Pty) ltd
15	ICL Industrial Products Ltd
16	International Council of Chemical Associations (ICCA)
17	JACOR, LLC. EcoBioClean
18	Kama Industries Limited
19	MVO Nederland (CSR Netherlands)
20	Nordic Paper
21	Novartis
22	Pfizer Inc.
23	The Dow Chemical Company
Civil society	
24	Center for Public Health and Environmental Development (CEPHED), Nepal
25	Centre for Environment, Women, Education and Development (CEEWED), Nigeria
26	ChemSec, Sweden
27	International POPs Elimination Network (IPEN)
28	International Union of Pure and Applied Chemistry (IUPAC)
29	PAN Asia Pacific, Malaysia
30	PETA International Science Consortium
31	The Work Health and SurvivalProject, Greece
Academia	
32	Darmstadt University of Applied Sciences, Germany
33	Faculty of Technology and Metallurgy, Cleaner Production Centre of Serbia
34	Fundación Universidad de América, Colombia
35	Korea Research Institute of Chemical Technology, South Korea
36	Leuphana University, Germany
37	Stockholm University, Sweden
38	The Water Academy, France

Annex B: List of Cases and Entities Undertaking them

(number in brackets corresponds to list in Annex A; note: consistent and comprehensive information was not available on the status and timeline for implementation of a number of cases)

Public sector

5-point programme for sustainable plant protection (4)
Entity: German Environment Agency, International Chemicals Management, Germany
Summary: Provides principles for an integrated approach to sustainable plant protection.

Best practice code for the application of anticoagulant rodenticides (4)
Entity: The Federal Institute for Occupational Safety and Health (BAUA), Germany
Summary: A legally binding code regulating biocidal products containing anticoagulant rodenticides.

Biocides – Proposal for a concerted European approach towards a sustainable use (4)
Entity: German Environment Agency, International Chemicals Management, Germany
Summary: Proposes regulatory action to minimize the use and the effects of biocides.

Bioconversion of crude glycerol to ethylene (1)
Entity: Agricultural Research Council, Institute for Agricultural Engineering, South Africa
Summary: Introduction of a biological, renewable alternative to the thermochemical approach in ethylene production.

Chemical leasing (2)
Entity: Environment Ministry, DG Waste, Chemicals Green Tec, Austria
Summary: Use of chemical leasing business model to reduce use of chemicals/improve efficiency.

Chemicals Management in Bahrain (7)
Entity: Supreme Council for Environment, Chemicals management Unit, Bahrain
Summary: Establishment of a comprehensive regulatory system related to chemicals management.

Chemical Substitution – Corrosion Inhibitors (5)
Entity: Tema Oil Refinery (TOR) Ltd., Ghana.
Summary: Replacement of chemicals of concern used in treatment of cooling water and as oxygen scavenger in petroleum refining.

Climate Change Mitigation (5)
Entity: Tema Oil Refinery (TOR) Ltd., Ghana.
Summary: Replacement of a catalyst used in cracking in petroleum refining.

Desulfurization of Petroleum Products (5)
Entity: Tema Oil Refinery (TOR) Ltd., Ghana.
Summary: Improving existing process plants to remove sulfur in petroleum refining.

Funding sound management of chemicals and hazardous wastes in Yemen (3)
Entity: Environment Protection Authority (EPA), General Department of Chemical Safety & Hazardous wastes, Yemen
Summary: Strengthening of human resources for the sound management of chemicals and hazardous wastes.

Indicator set "Parameters of Sustainable Chemistry" (PSC) (4)

Entity: German Environment Agency, International Chemicals Management, Germany
Summary: An indicator to assess specific sustainability measures applied in enterprises, mainly focused on processes and production.

International Sustainable Chemistry Collaborative Centre (ISC3) (4)
Entity: International Sustainable Chemistry Collaborative Centre (ISC3), Germany
Summary: Establishment of a centre to establish sustainable chemistry worldwide as a key component of sustainable development, addressing among others the dissemination of business models, support for developing countries in the safe management of chemicals, guidance on regulation etc.

Joint Office for Chemical Permissions (7)
Entity: Supreme Council for Environment, Chemicals management Unit, Bahrain
Summary: Establishment of a new office to join all related government authorities to permit and release chemicals rapidly.

Letter by the Permanent Mission of Mexico (6)
Entity: The permanent mission of Mexico, Mexico
Summary: A note indicating that no best practices have yet been identified.

National Action Plan on Sustainable Use of Plant Protection products (4)
Entity: The Federal Ministry of Food and Agriculture (BMEL), Germany
Summary: Qualitative regulations, targets, measures, indicators and timetables to reduce risks from the use of approved plant protection products.

Resource Efficiency - Cleaner Production and Waste Management (5)
Entity: Tema Oil Refinery (TOR) Ltd., Ghana
Summary: Replacement of fuel oil in firing boilers and furnaces in oil refining.

Sub-select and guidance on sustainable chemicals (4)
Entity: German Environment Agency, International Chemicals Management, Germany
Summary: A tool to measure and compare the sustainability of substances and mixtures based on chemical properties.

The German Chemical Leasing Initiative (4)
Entity: German Environment Agency, International Chemicals Management, Germany
Summary: National chemical leasing project in multiple industry sectors to reduce the use of chemicals.

Intergovernmental organizations

UNIDO's Global Chemical Leasing Programme (9)
Entity: UNIDO and the Governments of Austria, Germany and Switzerland à multiple stakeholders
Summary: The programme promotes the chemical leasing concept as a service-oriented circular economy business model that can effectively address the different sustainability dimensions of chemical use.

OECD Web Portal on PFASs (8)
Entity: The Organisation for Economic Co-operation and Development (OECD), EHS Division, France
Summary: Information exchange platform on per and poly-fluorinated chemicals (including risk reduction approaches) and their alternatives.

Substitution and Alternatives Assessment Toolbox (8)
Entity: The Organisation for Economic Co-operation and Development (OECD), EHS Division, France

Summary: A toolbox that provides resources for chemical substitution and alternatives assessments.

Private sector

A biological alternative to chemical in the treatment of cooling liquid microbial (11)
Entity: Amoéba SA
Summary: Use of a biological biocide to treat water in cooling towers of industrial or institutional sites.

Audi-PtG-Anlage (4)
Entity: Audi AG
Summary: Carbon capture and utilization via methane synthesis for further development of the Power to Gas technology for the operation of motor vehicles.

BASF – Argan program in Morocco (4)
Entity: BASF
Summary: Delivery of biologically produced Argan oil and its bio-products under fair-trade conditions by a cooperative network employing a large number of women from rural areas.

BASF-Trilon-M (4)
Entity: BASF
Summary: Phosphates in dishwashing tabs replaced by Trilon-M formulations.

Biomass Balance approach – A ground-breaking way of using renewable resources in production (12)
Entity: BASF SE, Sustainability Strategy
Summary: Sale of certified biomass balance products which rely on the use of renewable resources to replace fossil fuels in integrated production systems.

BLUEDGE™ Polymeric Flame Retardant Technology (23)
Entity: The Dow Chemical Company, Dow Coating Materials
Summary: A flame retardant technology with low toxicity relative to hexabromocyclododecane.

CANVERA™ Polyolefin Dispersion for Can Coatings (23)
Entity: The Dow Chemical Company, Dow Coating Materials
Summary: A water and energy efficient alternative to bisphenol A, styrene or formaldehyde in food and beverage metal packaging.

Capacity Building to Foster the Sound Management of Chemicals (16)
Entity: The International Council of Chemical Associations (ICCA)
Summary: Voluntary industry initiative for capacity-building and product stewardship to implement environment, health and safety programs to manage chemical products throughout their lifecycle.

Chemistry for Green Building (10)
Entity: American Chemistry Council, Regulatory and Technical Affairs
Summary: Third-party auditing and supply chain guidance to certify the standards of buildings and building materials and products.

Covestro-Dream-Production (4)
Entity: Covestro
Summary: Carbon capture and utilisation via a catalyst that uses carbon dioxide instead of propylene oxide as a co-raw material in polyol synthesis.

Covestro-IMPACT-Technologie (4)
Entity: Covestro
Summary: Catalyst replacement of potassium hydroxide with double metal cyanide for higher quality and more sustainable polyether polyols.

Dow HYPOL Binder for Improving Technology in A Sustainable Manner (23)
Entity: The Dow Chemical Company, Polyurethanes
Summary: Replacement of TDI technology with MDI technology in the development of a grow tile with binding properties allowing the provision of green spaces in places where it is usually not possible.

EcoBioClean Solves a Global Problem (17)
Entity: JACOR, LLC. EcoBioClean
Summary: Reverse-engineering of crude oil into bio-available components via a biocatalyst, reducing need for potentially toxic chemical reaction solvents.

Global Regulatory Monitoring System of chemical Substances (GRMS2) (13)
Entity: European Automobile Manufacturers' Association (ACEA) Environment
Summary: Monitoring and development of a database covering developments in chemicals legislation worldwide.

Green and sustainable technologies to develop a greener and more energy efficient process to manufacture Pregabalin, active ingredient in the drug Lyrica® (22)
Entity: Pfizer Inc., Chemical R&D/Worldwide R&D
Summary: Replacement of organic solvents with a biocatalyst for increased energy efficiency and higher output.

Green Chemistry and Commerce Council (27)
Entity: Green Chemistry and Commerce Council (GC3)
Summary: A business to business group working to accelerate implementation of green chemistry.

Kilian – Functional substitution (4)
Entity: Kilian Industrieschilder
Summary: A regenerative substitution of toxic solvents with fatty acid esters from coconut oils in the production of industrial labels.

Nanomaterials and Sustainability (4)
Entity: Öko-Institut
Summary: A tool to evaluate the sustainability of nanotechnology applications.

Natural Greaseproof (20)
Entity: Nordic Paper
Summary: Replacement of PFAS in treated paper using mechanical treatment of wood fibres.

Prometho GmbH – GrüneTinte (4)
Entity: Prometho
Summary: Replacement of finite and hazardous raw materials for the manufacture of black ink with renewable and non-hazardous feedstocks obtained from biomass.

Removing organic solvents from our processes (21)
Entity: Novartis, Chemical Development
Summary: Surfactant-mediated chemistry as a higher output, less costly, less organic solvent-reliant alternative in pharmaceuticals production.

SAFR®: Integrating exposure with hazard in a new assessment approach for responsible flame retardant solutions (13)
Entity: ICL Industrial Products Ltd, Product stewardship
Summary: A tool to help flame retardant users to choose a suitable product relative to the level of hazard and exposure.

Small scale fisheries waste recycling project (15)
Entity: Foi Sciennce (Pty) ltd, Research
Summary: Collection of waste from fish processing companies for use in wound and burn relief products, food additive etc.

Süd-Chemie: Waste Water Treatment (4)
Entity: Süd-Chemie AG
Summary: Commissioning of a plant capable of separating heavy metal nitrates from the wastewater.

Sustainable Solution Steering® - Contributing to sustainability needs (12)
Entity: BASF SE, Sustainability Strategy
Summary: Use of an assessment method to analyse the sustainability of the entire product portfolio.

Sustainable Substitution Criteria (13)
Entity: European Automobile Manufacturers' Association (ACEA) Environment
Summary: Development of criteria for selecting safe non-regulated chemical alternatives to avoid regrettable substitutions.

Treatment of Effluent (18)
Entity: Kama Industries Limited
Summary: Environmentally sound waste management at a pharmaceutical manufacturing plant.

Usage of safer chemicals in the lab (18)
Entity: Kama Industries Limited
Summary: Replacement of chemicals of concern used in the production of pharmaceuticals.

Use of Green chemistry tools to influence route development for drug candidates (22)
Entity: Pfizer Inc., Chemical R&D/Worldwide R&D
Summary: Innovation and utilization of green chemistry tools such as solvent and reagent selection guides to improve the environmental performance in the synthesis of active pharmaceutical ingredients.

Waste Heat Recovery (4)
Entity: Deutsche Gasrußwerke (DGW)
Summary: Waste heat recovery, water recycling and the minimization of odour pollution in the furnace-black process.

Civil society

Banning of Import, Sale, Distribution and Uses of Asbestos in Nepal (24)
Entity: CEPHED, Environment and Public Health, Nepal
Summary: Awareness-raising campaign for a ban on the import, sale, distribution and use of asbestos.

Banning of Import, Purchase and Uses of all mercury based equipment's in health sector of Nepal (24)
Entity: CEPHED, Environment and Public Health, Nepal

Summary: Awareness-raising and capacity building efforts regarding the handling of mercury based equipment in the health sector.

Campaign for Standard of Children Toys (24)
Entity: CEPHED, Environment and Public Health, Nepal
Summary: Awareness-raising campaign for standards on chemicals of concern in children's toys.

Chemical Footprint Project (27)
Entity: Chemical Footprint Project (CFP), United States
Summary: A performance assessment of a company's management of chemicals, identifying opportunities for improvement.

ChemSec Marketplace (26)
Entity: ChemSec, Sweden
Summary: A platform for substitution of hazardous chemicals, featuring advertisements of safer alternatives from producers, as well as requests for safer alternatives from downstream users.

Elimination of POPs and its Sources in Nepal (24)
Entity: CEPHED, Environment and Public Health, Nepal
Summary: Capacity-building and training on best practices to avoid waste burning at healthcare facilities as well as open burning.

Global Perspective on Success Stories and Best Practices in Chemical Safety Protecting Occupational and Environmental Health (31)
Entity: The Work Health and SurvivalProject, Sustainability and Law, Greece
Summary: Advocacy piece on the protection of occupational health and safety.

GreenScreen (27)
Entity: Clean Production Action, United States
Summary: A tool implemented by major corporations to identify hazardous chemicals and alternatives. The tool can guide procurement, product design, standards and policies.

Promoting PCB Free Metal Fabrication through Technology Transfer (24)
Entity: CEPHED, Environment and Public Health, Nepal Replacing Chemicals With Biology:
Summary: PCB containing/contaminated oil based welding machines replaced by dry welding machines, to protect grill workers and reduce contamination, including of dioxins and furans.

Phasing out Highly Hazardous Pesticides with Agroecology (29)
Entity: PAN Asia Pacific, Pesticides, Malaysia
Summary: Provision of assistance and practical guidance for policy- and decision-makers as well as farmers to replace highly hazardous pesticides with ecosystem-based approaches in order to reduce human health and environmental impacts, while also addressing food security, poverty and climate change.

Research based campaign for Mandatory Lead Paint Standard in Nepal (24)
Entity: CEPHED, Environment and Public Health, Nepal
Summary: Awareness-raising campaign on lead content in paint as well as lead contamination in buildings to advocate for the establishment of mandatory lead paint standards.

Sustainable Chemistry Policy Action Plan (25)
Entity: Centre for Environment, Women, Education and Development (Ceewed), Management, Nigeria
Summary: Development of a multi-stakeholder strategy for sustainable chemicals management.

Use of non-animal methods to develop safer chemicals (30)
Entity: PETA International Science Consortium, United States
Summary: Use of robust non-animal testing methods to assess toxicity in the development of safer chemicals and products.

Academia

Chemical Leasing (33)
Entity: Faculty of Technology and Metallurgy, Cleaner Production Centre of Serbia
Summary: Glue is invoiced to the user by number of glued boxes, not per kilogram.

Chemical Leasing in automotive parts industry (33)
Entity: Faculty of Technology and Metallurgy, Cleaner Production Centre of Serbia
Summary: Application of the chemical leasing business model in cleaning operations to reduce the use of hazardous chemicals, thus also protecting workers.

Chemical Leasing in Hotels (33)
Entity: Faculty of Technology and Metallurgy, Cleaner Production Centre of Serbia
Summary: The cleaning agents (for cutlery, laundry and rooms) are invoiced per kilogram of washed laundry or per occupied room instead per kilograms of chemicals.

For an IPCPE (international panel on the chemical pollution of the environment) to create an international expert body to periodically assess the state of the chemical pollution of the environment on the model of the IPCC or the IPBES (38)
Entity: The Water Academy, Board, France
Summary: Establishment of an international expert body to assess chemical pollution.

Identification of Sustainable Alternatives to Replace the Use of Asbestos in the Automotive Sector (34)
Entity: Fundación Universidad de América, Research, Colombia
Summary: Development of a documentary to raise awareness about the negative effects of asbestos, including exposure of workers, and to advocate for the phase out of its use in the automotive sector as well as other products.

IUPAC submission (28)
Entity: International Union of Pure and Applied Chemistry (IUPAC), Interdivisional Committee on Green Chemistry for Sustainable Development (ICGCSD), United States
Summary: Note on the interface between sustainable chemistry and green chemistry.

Safe and sustainable nanotechnology practices (37)
Entity: Stockholm University, Department of Computer and Systems Sciences, Sweden
Summary: Note on the nanotechnology sector, including a discussion of potential health and environmental issues from the use of nanotechnology.

Series of Postgraduate Summer Schools on Green Chemistry (28)
Entity: International Union of Pure and Applied Chemistry (IUPAC), Interdivisional Committee on Green Chemistry for Sustainable Development (ICGCSD), United States
Summary: Following ten previous Summer Schools on Green Chemistry organised by the University of Venice, Interuniversity Consortium, Chemistry for the Environment, the new series of summer schools aims to teach students and researchers in chemistry how to apply principles of green chemistry to drive sustainable development.

Sustainable synthetic biology (37)
Entity: Stockholm University, Department of Computer and Systems Sciences, Sweden
Summary: Concept note advocating for the environmentally sound use of synthetic biology to avoid potential negative impacts while harnessing its potential.

Utilization of steel slag as a multi-purpose sorbent for pollutants (35)
Entity: Korea Research Institute of Chemical Technology, Center for Chemical Safety and Security, South Korea
Summary: Recycling of steel slag in environmental applications, such as acid-spill response, carbon dioxide sequestration, and sorbents for fluoride or heavy metals.

Wiki for chemical substance data to foster sound management of chemicals (32)
Entity: Darmstadt University of Applied Sciences, Society for Institutional Analysis (sofia), Germany
Summary: Adding of dashboards to the RWACH online registration dossiers featuring all available peer-reviewed studies on the respective substance.

Multi-stakeholder

3M – Recycling of PTFE (4)
Entity: 3M, Germany, the University of Bayreuth and the research institute InVerTec, Germany
Summary: Development of a pilot plant producing recycled high quality polytetrafluorethene from end of life material.

Chemical leasing – efficient and sustainable hospital hygiene (36)
Entity: Schülke & Mayr GmbH, OPAL Service GmbH, Klinikum Worms, Institut für Umweltmedizin und Krankenhaushygiene (IUK), Leuphana Universität Lüneburg and Deutsche Bundestiftung Umwelt (DBU)
Summary: The project focussed on a certain standard of hygiene needed in a medical environment instead of selling disinfectants only thus reducing disinfectant use on the one hand and creating revenue by service such as training.

Convening Diverse Stakeholders on Chemistry in Sustainable Development (16)
Entity: The International Council of Chemical Associations (ICCA), UN Environment; and the China Petroleum and Chemical Industry Federation
Summary: A multi-stakeholder workshop exploring the role of chemistry in achieving sustainable development.

New interesting tool: The Sustainability Hotspot Scan (19)
Entity: MVO Nederland (CSR Netherlands), International CSR Program; the research institute Netherlands Organization for Applied Scientific Research (TNO), Netherlands; Baril Coatings B.V., C. Kornuyt BV; and the Dutch Institute for Health and Environment (RIVM), Netherlands
Summary: Development of a tool allowing chemical companies to assess the social and environmental impact of chemical products during their life cycle.

PERO & SAFECHEM – Cleaning of metal parts (4)
Entity: Safechem, Germany and Pero Innovative Services
Summary: Use of the chemical leasing business model to incentivise companies to consume fewer chemicals for the process of industrial parts cleaning for an automotive supplier.