COMPILATION OF ILLUSTRATIVE EXAMPLES RECEIVED IN THE PREPARARATION PHASE OF MANUALS ON GREEN AND SUSTAINABLE CHEMISTRY

Compilation of illustrative examples received in the preparation phase of manuals on green and sustainable chemistry.

A call for submissions was circulated amongst the key stakeholders to submit illustrative examples of green and sustainable chemistry in May 2020. This document is a compilation and analysis of the examples that were submitted from different stakeholders

Background Information

In response to the Fourth United Nations Environment Assembly (UNEA-4) Resolution 4/8, the United Nations Environment Programme is preparing Manuals on Green and Sustainable Chemistry. The Manuals take stock of various developments related to green and sustainable chemistry and seek to provide practical guidance to stakeholders. A framework manual has been completed that fosters a vision of green and sustainable chemistry which emphasizes the potential of chemistry to become fully compatible with the 2030 Agenda for Sustainable Development. The manual introduces various facets of green and sustainable chemistry in a structured way to inspire learning, reflection and scaling-up action based on a common global understanding of the green and sustainable chemistry concept. The full report and its accompanying executive summary can be found here.

Figure 1: The 10 Guiding and Considerations for Green and Sustainable Chemistry

In May of 2020 during the preparation of the Framework Manual, UN Environment Programme sent a call for submission of illustrative examples of green and sustainable chemistry to stakeholders having relevant experience with the issue of sustainable chemistry. A previous report responding to a mandate provided through Resolution 2/7 on the sound management of chemicals and waste, adapted at the second session of the United Nations Environment Assembly in May 2016 requested stakeholders to submit best practices of sustainable chemistry and to prepare a report in the first quarter of 2018. These examples originally were meant to complement the previously submitted best practices. However, they have come to serve as powerful reference for the 10 objectives and guiding considerations (Figure 1) around which the Framework manual is centered. The illustrative examples have been compiled and analyzed and are presented in the following two annexes. Annex A provides an overview of the types of institutions/organizations which responded to the call while Annex B provides a tagged list and summary for each of the submitted examples.

** The summaries have been prepared by the submitters themselves and UNEP does not confirm or deny any of the claims made in the written summaries **

Annex A: Analysis and categorization of submitted illustrative examples.

Data Collection and Stakeholder Responses

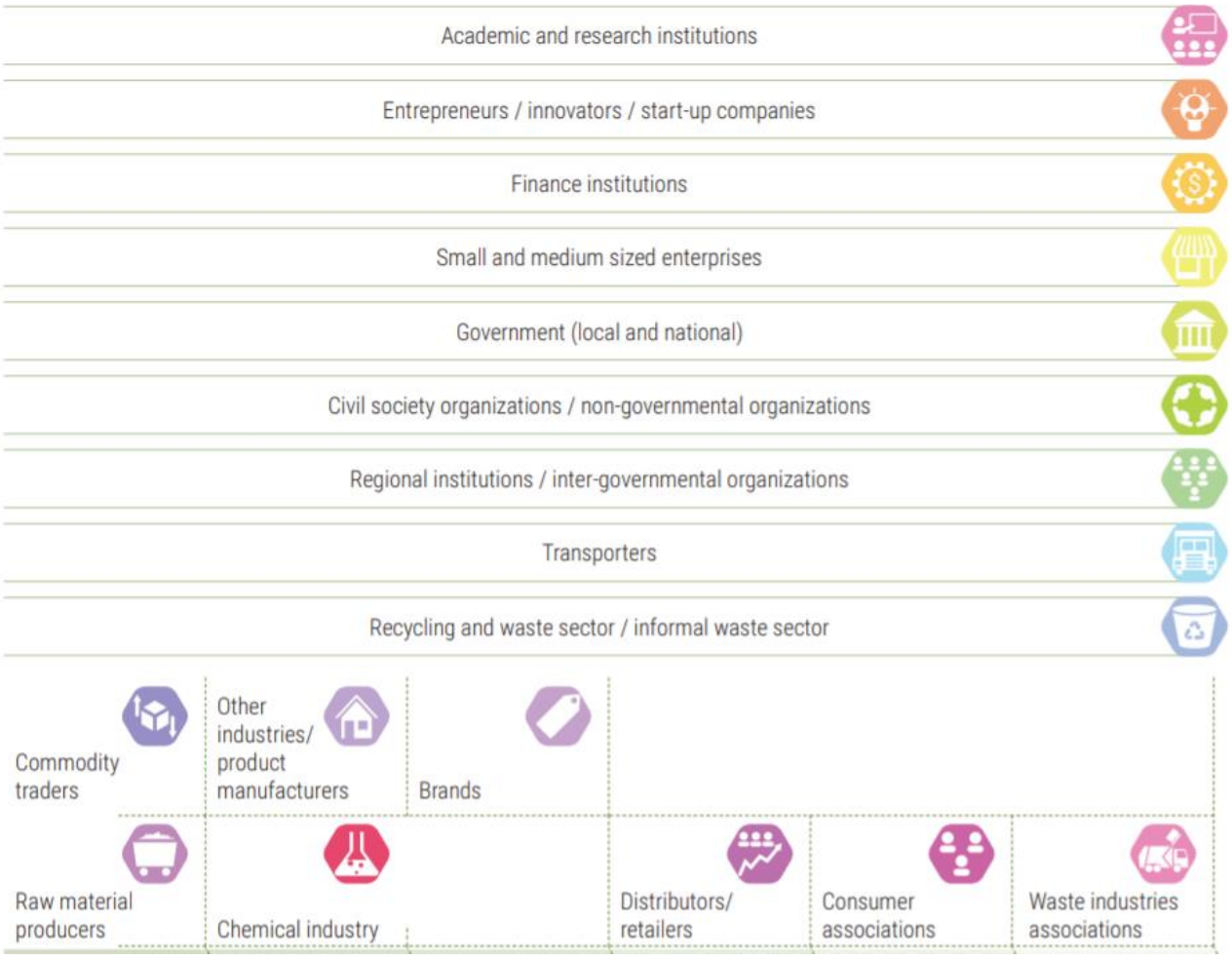
A total of 14 stakeholders responded, submitting 65 illustrative examples of green and sustainable chemistry. Table 2 provides an overview of the origin of the submissions of the examples, coming from a range of public and private institutions.

Table 1: A display of the origins of the submitted examples.

#	Institution/organization	No. of examples submitted
Government		
1	Department of Commerce USA	1
2	U.S. International Trade Commission	1
3	German Federal Environment Agency	18
Civil Society Organization		
4	ChemForward	1
Business/ Private Sector		
5	Scivera USA	1
6	Warner Babcock Institute for Green Chemistry	1
7	Collaborative Aggregates	12
8	ZDHC Foundation	1
Academia		
9	University of California, Irvine	4
10	Universidad ORT Uruguay	3
11	Federal University of Sao Carlos	2
12	Leuphana University	1
13	Universidad Pontificia Bolivariana	3
14	Mendeleev University of Chemical Technology of Russia	2
Others		
15	International Sustainable Chemistry Collaborative Centre (ISC3)	14
	Total	**65**

Many of the submissions are multi-stakeholder initiatives which go on to target specific areas of the chemical value chain. The examples are therefore organized by stakeholder categories. A wide range of innovators in private industry, academia and government are involved in developing methods and frameworks for advancing green and sustainable chemistry. The sectors and areas of society which these innovators seek to transform and inform through green and sustainable chemistry is also diverse. To provide a picture of who is venturing to advance green and sustainable chemistry and the sectors they are targeting, both the stakeholder category of the principal submitter and their intended target stakeholder group or groups are presented for each example. The relevant stakeholder groups are presented in figure 2, taken from the Framework Manual.

Figure 2: Map of key stakeholders for green and sustainable chemistry from the Framework Manual



Annex B: List of illustrative examples submitted

Biotechnology applied to artisanal and small-scale gold mining to avoid the use of mercury in mining operations in Colombia

Submitted by:
Universidad Pontificia Bolivariana

Submitting Stakeholder Type:
Academic Institution

Target stakeholders:
Raw Material Producers

Summary:
The main goal of this project was the design and implementation of a pilot plant for mineral processing which avoided the use of mercury and furthered the development of social and environmental innovations. The project was supported by the Government of Antioquia through the funding of "Sistema General de Regalías - SGR" of Colombia.

This project was implemented using four components: Technical, Social, Environmental and Technology Management, seeking to ensure an integral intervention in communities, understanding their current situation and proposing a viable and innovative alternative that can be implemented and create value.
The core of this project is the development of a process for gold extraction avoiding the use of mercury or cyanides. Innovation resides in the biotechnological substance we produce to substitute for mercury as a raw material for gold extraction, creating a competitive and scalable process.

Copper leaching from waste printed circuit boards by typical ionic liquid acids

Submitted by:
University of California, Irvine

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Recycling and Waste

Summary:
Waste printed circuit boards (WPCBs) are attracting increasing concerns because the recovery of its content of valuable metallic resources requires the use of hazardous substances. In this study, we used six different non-toxic ionic liquids (IL) to leach copper from WPCBs. Factors that affect copper leaching rate were investigated in detail and their leaching kinetics were also examined and compared. The results showed that all six IL acids could successfully leach copper out, with near 100% recovery. WPCB particle size and leaching time had similar influences on copper leaching performance, while IL acid concentration, hydrogen peroxide addition, solid to liquid ratio, temperature, showed different influences.

Design of Bioepoxy-Flax Composites for Printed Circuit Boards

Submitted by:
University of California, Irvine

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Product Manufacturers

Summary:
Printed circuit boards (PCBs) pose considerable occupational health risks during manufacturing and are a potential source of toxic hazards if improperly disposed at the end of their useful life. Indeed, base materials in current PCBs include epoxy resins, fiberglass, and brominated flame retardants. To improve the environmental performance of PCB manufacturing and disposal, we developed composite designs using a thermosetting matrix based on epoxidized linseed oil, melamine polyphosphate for flame retardance, and woven flax fiber for reinforcement.
Analyses of our prototypes using IPC 4101A/24 specification for thick PCB laminates gave acceptable results for thermal, mechanical, and electrical properties, except for wet conditioning or water submersion. To improve moisture resistance, we treated flax fibers with sodium hydroxide and octadecyl trichlorosilane. We find that the improved bio epoxy-flax PCB design is a viable alternative to current PCBs; it has potentially lower environmental impacts, it is cheaper, and it has satisfactory thermal, electrical, and mechanical properties. However, additional improvements in moisture absorption properties may remain needed for commercial applications.

Electronic waste disassembly with industrial waste heat

Submitted by:
University of California, Irvine

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Recycling and Waste

Summary:
Waste printed circuit boards (WPCBs) are resource-rich but hazardous, demanding innovative strategies for post-consumer collection, recycling, and mining for economically precious constituents. A novel technology for disassembling electronic components from WPCBs is proposed, using hot air to melt solders and to separate the components and base boards.
An automatic heated-air disassembling equipment was designed to operate at a heating source temperature at a maximum of 260 °C and an inlet pressure of 0.5 MPa. A total of 13 individual WPCBs were subjected to disassembling tests at different preheat temperatures in increments of 20 °C between 80 and 160 °C,

heating source temperatures ranging from 220 to 300 °C in increments of 20 °C, and incubation periods of 1, 2, 4, 6, or 8 min. For each experimental treatment, the disassembly efficiency was calculated as the ratio of electronic components released from the board to the total number of its original components. The optimal preheat temperature, heating source temperature, and incubation period to disassemble intact components were 120 °C, 260 °C, and 2 min, respectively. The disassembly rate of small surface mount components (side length ≤ 3 mm) was 40–50% lower than that of other surface mount components and pin through hole components.
Based on these results, a reproducible and sustainable industrial ecological protocol using steam produced by industrial exhaust heat coupled to electronic-waste recycling is proposed, providing an efficient, promising, and green method for both electronic component recovery and industrial exhaust heat reutilization.

Free 10-hour on-line course on Green and Sustainable Chemistry launched via UFSCar´s Moodle platform (in Portuguese and English), supported by IUPAC

Submitted by:
Federal University of Sao Carlos

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Academic Institution, Civil Society Organizations

Summary:
Course Description: The course aims to present the socio-historical context of the development of Green and Sustainable Chemistry, associated with the United Nations (UN) 2030 Agenda, as well as to enable people/students to understand the principles of GSC and apply them to selected case studies, highlighting Brazilian examples.
Course Objective: To understand the fundamentals and applications of Green and Sustainable Chemistry from a STSE (Science, Technology, Society and Environment) perspective, associated with the UN 2030 Agenda.
Study Units:1) Chemistry and Sustainability: a possible dialogue; 2) Green and Sustainable Chemistry: from principles and means to applications.

Field & Food Tech Hub - UFSCar (Ethical and healthy living promoted by green and sustainable products and processes from farm to fork and beyond, from Sao Paulo State, Brazil)

Submitted by:
Federal University of Sao Carlos

Submitting Stakeholder Type:
Academia

Target Stakeholder/s:
Small and Medium sized enterprises, Chemical Industry, Recycling and Waste

Summary:
The tasks, strategies, guidelines, business models and practices that constitute the concept of green and sustainable socio-scientific technologies in agro-industrial, food, beverage systems and similar areas have been established based on consolidated scientific networks, not only in chemistry, engineering, computing and medicine, but also in humanities. Field & Food Tech Hub's mission is to bring together initiatives from São Carlos regarding the design, production, distribution, consumption and management of biomass or agro-industrial chain residues and other appropriate materials so as to promote human health and the environment considering the UN sustainable development goals.

Fique Residues as Green Raw Material for Industrial Applications: Columbia

Submitted by:
Universidad Pontificia Bolivariana

Submitting Stakeholder:
Academic Institution

Target Stakeholder/s:
Innovators, Recycling and Waste, Academic Institutions

Summary:
Fique is a native plant from Andean region; its leaves are employed to extract fibers mainly used in the manufacture of bags for packaging agro-industrial products such as coffee, rope, agro-textiles, and crafts among other applications. However only 4% of the plant is useful and the 96% remaining represents a toxic residue comprising liquid or juice, and bagasse. The current carbon footprint associated to fique fiber processing is roughly 1.12 Kg CO2 per kilogram of processed fiber. With the implementation of this technology, it is expected to reduce the carbon footprint by more than 8%.

Biopesticides produced from fique residues could substitute chemical additives employed in agro-protection, reducing environmental impact and public health hazards in the agro-value chain. The development of this technology is a demonstrative example of how a toxic residue could be transformed in a business opportunity to create value and simultaneously reduce environmental impact, creating responsible processes and democratizing the science and technology in the whole chain values to integrate the efforts of academia, industry, farmers, the market and the government.

Green chemistry for the optimum technology of biological conversion of vegetable waste

Submitted by:
Mendeleev University of Chemical Technology of Russia

Submitting Stakeholder:
Academic Institutions

Target Stakeholder/s:
Chemical Industry, Small and Medium Sized Enterprises, Innovators

Summary:
The research presented is an original algorithm for multi-criterion green process assessment for renewable raw materials bioconversion. The algorithm is used when several processes for obtaining the same target substance N are available (or under different conditions). In this case, the researcher's task is to choose the best process in compliance with the principles of green chemistry. For example, to assess compliance of the process with:
- Principle# 1, Minimize the generation of waste. Waste weight or mass intensity can be used as indicator i, and the value of the indicator "waste weight" must be minimal, and the value of indicator "mass intensity" must be the maximum;
- Principle # 3, Use of hazardous substances should be minimized and may be used as an indicator of hazardous substances total weight;
- Principle # 6 (energy efficiency) The total energy spent.

Bio-catalyzed production of acrylamide

Submitted by:
Universidad ORT Uruguay

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Chemical Industry

Summary:
This is a biocatalytic application for the 650 000 tonnes produced annually of acrylamide. Traditional sulphuric acid and RANEY® Cu-catalysed industrial processes could lead to hydrolysis of the desired acrylonitrile to acrylic acid and additionally they lead to polymerization of the carbon-carbon double bond. Moreover, in both cases, a coloured product was obtained that required decolouring steps. Additionally, the preparation of the Cu catalyst is laborious and requires high temperatures.

The enzyme Rhodococcus rhodochrous J1 overexpressing a nitrile hydratase converts acrylonitrile into acrylamide at up to 50% weight ratio under mild conditions, yielding >99.99% of final product with a space–time yield of ∼2 kg L−1 d−1.8 This biotransformation is one of the largest industrial biotransformation processes in Japan and Germany where it produces over 650 000 tonnes per year of acrylamide.

Bio-catalyzed production of Cephalexin

Submitted by:
Universidad ORT Uruguay

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:

Chemical Industry

Summary:
By advanced enzyme and metabolic engineering DSM was able to replace the traditional 10-step, mainly chemical synthesis by a fermentative route followed by two mild enzymatic steps. The white biotech process has been shown to use far less energy (–65%), less input of (harsh) chemicals (–65%), is water-based, generates less waste, and is very cost-effective (–50%).

Professional Master in Sustainable Chemistry in Germany

Submitted by:
Leuphana University

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Academic Institutions

Summary:
Launching in March 2020, the professional Masters program M.Sc. Sustainable Chemistry provides expert interdisciplinary training in sustainable chemistry. Our unique curriculum teaches –product flows from the molecular to global levels, sustainability assessment and alternative business models for chemical products and how to understand and apply chemistry in the context of sustainability.

Chemistry is the key enabling science for the products we use in our everyday life. Every sector of our society, from agriculture, healthcare, mobility, energy to the digital sector has been and is being shaped by chemical innovations. While substantially contributing to our health and wellbeing, chemistry plays an important role in facing today's challenges of resource depletion, climate change and pollution as well as for securing a sustainable development of our societies. These are key messages meant to be communicated to students of the Masters program.

Thermal degradation and pollutant emission from waste printed circuit boards mounted with electronic components

Submitted by:
University of California, Irvine

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Recycling and Waste, Government, Civil Society/Non-Governmental Organizations

Summary:
Waste printed circuit boards mounted with electronic components (WPCB-ECs) are generated from electronic waste dismantling and recycling process. Air-borne pollutants, including particulate matter (PM)

and volatile organic compounds (VOCs), can be released during thermal treatment of WPCB-CEs. In this study, organic substances from WPCB-ECs were pyrolyzed by both thermo-gravimetric analysis (TGA) and in a quartz tube furnace. We discovered that board resin and solder coating were degraded in a one-stage process, whereas capacitor scarfskin and wire jacket had two degradation stages.

Debromination of brominated flame retardants occurred, and HBr and phenol were the main products during TGA processing of board resin. Dehydrochlorination occurred, and HCl, benzene and toluene were detected during the pyrolysis of capacitor scarfskin. Benzene formation was found only in the first degradation stage (272–372 °C), while toluene was formed both in the two degradation stages. PM with bimodal mass size distributions at diameters of 0.45–0.5 and 4–5 μm were emitted during heating WPCB-ECs. The PM number concentrations were highest in the size ranges of 0.3–0.35 μm and 1.6–2 μm. The research produced new data on pollutant emissions during thermal treatment of WPCB-ECs, and information on strategies to prevent toxic exposures that compromise the health of recyclers.

Sociological survey to assess the readiness of Russian enterprises to follow the principles of green chemistry - All Russian Federation

Submitted by:
Mendeleev University of Chemical Technology of Russia

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Government, Chemical Industry, Brands

Summary:
This was a survey conducted by polling enterprises in the chemical sector and related industries to gather information on the willingness and readiness of Russia's industry to advance green chemistry practices.

The sampling represented various sizes and sectors of industries. It included companies that mine and enrich chemical minerals (phosphates, apatites, and potassium salts) and produce mineral salts, alkalis, inorganic acids, chlorine, ammonia, fertilizers, plant protection chemicals, chemical feeds, synthetic dyes (organic dyes, intermediates, and synthetic hardeners), white paints, dyes, lacquers, enamels, nitrocellulose enamels, synthetic resins and plastic materials, artificial and synthetic fibers, and yarns, plastic products, glass, fiber materials, fiberglass and its derivatives, synthetic rubber, chemicals, high purity substances, and catalysts, photographic and motion picture films, magnetic tapes, drugs and medicines, household chemicals, organic synthesis products (including petroleum products and carbon black), rubber and asbestos products, explosives, ammunition and special chemicals, pulp and paper products, ferrous and nonferrous metals, and personal protective equipment.

Synthesis of 5-cyanovaleramide, a herbicide intermediate - for advancing sustainability and production and minimizing chemical releases and pollution.

Submitted by:
Universidad ORT Uruguay

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Chemical Industry

Summary:
5-cyanovaleramide, a herbicide intermediate is produced by DuPont via regioselective NHase bio-catalysed hydration of adiponitrile. Resulting in the generation of fewer byproducts and less waste than processes using metal catalysts such as RANEY®Cu or MnO2.

System for solvent separation by using cereals with low energy consumption principles

Submitted by:
Universidad Pontificia Bolivariana

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Chemical Industry, Product Manufacturers

Summary:
The research group CIBIOT in the Faculty of Chemical Engineering at Universidad Pontificia Bolivariana developed a self-regenerating separation system for the separation and purification of solvents by feeding a stream of an aqueous solvent solution to a packed column with a bed made up of mineral or cereal materials such as corn. The obtained solvents possessed a concentration greater than 99.5% (v/v) purity. The technology was patented, and its configuration reduces energy and cooling water consumption. The cereal is fed just one time for its operation, so there is a reduction in the operational cost. It can be operated with natural gas.

In comparison with distillation, membranes, and other engineering solutions for solvent separation, this technology requires 5 times less energy, it is modular, automatable and can be operated in both rural and urban areas.

Potential users: Sectors in whose economic activity involve the purification of solvents by dehydration: paints, biotechnology, pharmaceuticals, cosmetics, resin and polymer producers, biofuels, among others.

Biodegradable alternatives to polyurethane-based foam cushioning.

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Brands, Consumer Associations

Summary:
A process has been invented to fabricate furniture cushioning by using a 3-D printed biopolymer frame filled with lyophilized cellulose. This 100% bio-based product has properties indistinguishable from traditional polyurethane foam containing products.

Biomimicry Based Tunable Adhesives

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Brands, Innovators

Summary:
In collaboration with Caddis Adhesives, adhesives inspired by the biochemistry of the Caddis Fly has been developed. This class of bio-based adhesives can be customized for many different applications.

BPA Free Thermal Imaging

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Academic Institutions, Product Manufacturers

Summary:
Many thermal imaging technologies use hazardous Bisphenol-A or similar molecules for color activation. This technology provides a method to create thermal images under similar conditions without using hazardous materials.

Delta Mist: Penetrating Asphalt Spray Rejuvenator Seal

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Governments, Civil Society and Non-Governmental Organizations

Summary:
This technology extends the useable life of an asphalt road. It is a nontoxic aqueous based spray coat that allows vehicles to resume use within hours of application. Surface lines and painting are unaffected by this technology, so repainting is unnecessary.

Delta-S: Plant Based Asphalt Warm-Mix Rejuvenator

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Governments, Civil Society and Non-Governmental Organizations, Waste and Recycling.

Summary:
This technology allows for the use of very high amounts of recycled asphalt pavement in road work. This nontoxic plant-based formulation also reduces the processing temperature.

Green Chemistry Fire Retardants

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Product Manufacturers, Chemical Industry

Summary:
By creating structured materials that undergo endothermic mixing, fire and heat suppression can be achieved without using toxic or environmentally problematic chemistries.

Green Chemistry Lithium Battery Recycling

Submitted by:
Warner Babcock Institute for Green Chemistry

Submitting Stakeholder Type:
Research Institution

Target Stakeholder/s:
Recycling and Waste, Consumer Associations, Raw Material Producers.

Summary:
This technology provides an efficient and cost-effective means to recover Lithium Cobalt Oxide from used batteries. By using an aqueous hydrolysis product of citrus oil, the appropriate conditions can be created to recover Lithium Cobalt Oxide by density separation.

Green Chemistry Wood Compositions

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Brands, Product Manufacturers.

Summary:
This technology provides a green chemistry alternative to traditional formaldehyde or isocyanate based engineered wood adhesives. This drop-in technology provides comparable mechanical properties at similar costs.

Lithographic Patterned Metal Oxides

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Chemical Industry

Summary:
This process avoids the use of toxic chemicals typical of lithographic deposition using a direct UV irradiation promoted deposition of Titanium Dioxide semiconductors on multiple substrates.

Photochromic Water Harvesting

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Government, Civil Society and Non-Governmental Organizations.

Summary:
By creating hydrophobic/hydrophilic photo-switchable patterns on film substrates, this invention provides a capture and release mechanism for water purification using ambient passive light.

Photo forward Osmosis for Desalination and water purification

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Government, Civil Society and Non-Governmental Organizations.

Summary:
This technology uses passive solar irradiation to trigger dissolution of a polymeric material that creates variable osmotic pressure differentials. This enables a "draw solution" to pull clean water passively through a membrane.

Plant Based Composites

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Product Manufacturers, Brands, Raw Material Producers

Summary:
This technology allows for the fabrication of bio-based composites that use microfibers from plant cellulose feedstocks.

Rare Earth Metal E-Waste Recovery

Submitted by:
Collaborative Aggregates

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Raw Material Producers, Recycling and Waste

Summary:
This technology uses green chemistry conditions to efficiently extract precious metals from E-waste.

SciveraLENS® Rapid Screen creates scalable capacity for safer alternatives selection in the global consumer product supply network

Submitted by:
Scivera

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Brands, Consumer Associations, Governments

Summary:
SciveraLENS® is a web-based software platform that has enabled many global apparel, electronics, toys, footwear, cosmetic, etc brands scale-up the screening, scoring, selection, and tracking of chemicals used in products and process. SciveraLENS® makes scalable, cost-effective, and easy to understand the work required for evidence-based review of chemicals to enable use of formulations and materials that are safer for workers, consumers, and the environment.

As an example, SciveraLENS® has facilitated the secure chemical data gathering, screening, scoring, and certification of over 500 textile chemical formulations during 2019. SciveraLENS® is the leading platform for implementing the Screened Chemistry Program developed by Levi Strauss & Co for their global supply network, and since also taken up by Nike, H&M, Gap, and others.

ZDHC Sustainable Chemistry: A Journey as a global example - sector specific for Textile, Garment and Leather sector.

Submitted by:
ZDHC

Submitting Stakeholder Type:
Product Manufacturers

Target Stakeholder/s:
Brands, Consumer Associations, Governments, Chemical Industry, Retailers

Summary:
ZDHC's vision and mission are the widespread implementation of sustainable chemistry, driving innovations, and best practices in the textile, apparel, leather, and footwear industries to protect consumers, workers, and the environment. ZDHC is working on safer alternative chemicals as conformity to ZDHC MRSL (Manufacturing Restricted Substances List). ZDHC is working with important stakeholders (Chemical manufacturing) towards the journey to sustainable chemistry. The illustrative example shows ZDHC long term journey to sustainable chemistry.

ChemForward: Globally Harmonized Repository of Chemical Hazard Assessments for Safer Alternatives

Submitted by:
ChemForward

Submitting Stakeholder Type:
Civil Society Organization

Target Stakeholder/s:
Brands, Consumer Associations, Governments, Retailers, Chemical Industry

Summary:
ChemFORWARD is a science, nonprofit collaboration of leading brands, retailers, and NGOs working to empower the value chain with high quality, actionable chemical hazard data.

The Challenge: Chemistry is the engine of modern material ecosystems. If we are going to keep materials flowing in commerce longer, we have to design them to be safe for human and environmental systems, because we can't change the chemistry of products once we put them out in the world. Without safe chemistry, a circular economy is not possible.

To eliminate toxic exposure and realize the potential of the circular economy, chemical management and optimization are essential for sustainable development and will directly contribute to UN Sustainable Development Goals (SDGs) 12 and 17. But, cost-effective, trusted data about chemical hazards and safer alternatives is a barrier for most companies. The only way to scale the use of definitive science to inform proactive decision making in the design phase of products is to create a globally harmonized, shared repository of verified hazard profiles and safer alternatives.

The Solution: ChemFORWARD is a science, nonprofit collaboration of leading brands, retailers, and NGOs working to empower the value chain with high quality, actionable chemical hazard data. We believe that access to better data leads to better decisions, creating better outcomes for humans and the environment.

ChemFORWARD is scaling the dataset for chemical hazard information and creating the business case to unlock the potential of a shared data.

Utilizing a universal GHS-based template that also accommodates leading methodologies such as GreenScreen and Cradle to Cradle, we house one third-party verified profile per CASRN. This enabling foundation of quality and consistency while eliminating redundant work, and lowering the cost of access to high quality hazard information for users.

3M - Recycling of PTFE

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Product Manufacturers/Academic Institution

Target Stakeholder/s:
Product Manufacturer, Recycling and Waste Sector

Summary:
3M together with the University of Bayreuth and the research institute InVerTec has developed a polymer recycling pilot plant that produces high quality polytetrafluorethene (PTFE) from end-of-life material. Fluoropolymers are irreplaceable materials in many industrial sectors due to their unique properties (e.g. high chemical and thermolysis resistance, very high melting point). The most important fluoropolymer is PTFE with a share of 60 % of total annual production. The European annual consumption of fluorinated polymers amounts to approximately 35,000 tonnes, of which 3M produces more than 16,000 tonnes. The global PTFE market is expected to grow by 5.6 % until 2022, mainly due to the rising demand in the Asia-Pacific region. Common strategies for PTFE (polytetrafluoroethene) at its end of life include incineration, landfilling, and downcycling.

In contrast, the developed pilot plant allows a real material recycling in the following way: By pyrolysis the end of life PTFE is converted to the monomer TFE (tetrafluorethene) which is then purified and again polymerized into high quality PTFE.

5-point programme for sustainable plant protection

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Chemical Industry, Product Manufacturers, Government

Summary:
In the 5-point programme for sustainable plant protection the German Environment Agency recommends for the achievement of sustainable development in plant protection an integrated approach for all relevant policy areas (plant protection, environment, nature conservation, and agriculture) based on the following five basic principles:

1) Minimising use, 2) Identifying, quantifying and communicating risks, 3) Optimising risk management, 4) Compensating for unavoidable effects, 5) Internalising external costs.

Advanced Manufacturing and Innovation in Chemicals Management Initiatives (AMICMIs).

Submitted by:
USA**,** Department of Commerce

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Chemical Industry, Product Manufacturers, Government, Brands

Summary:
The AMICMIs are engaged as a result of a common interest (country/regions/etc.) in greener products and processes/improved life cycle performances.

The ITA uses its commerce dialogues to introduce a Government-to-Government (G2G) information exchange and better understand who does what/where/how; agencies of competency share their knowledge and activities/can decide on furthering of goals and objectives and complementary activities; similarly, the Business-to-Business (B2B) information exchange can help strengthen collaborations on pre-commercial R&D, and/or market facilitation. AMICMIs dialogues took place with the EU, Brazil, the ASEAN, US-EU SMEs, etc.

Audi - Power to Gas

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Chemical Industry, Transport

Summary:
Carbon Capture and Utilization (CCU): Power to gas: methane synthesis from CO2 and hydrogen with regenerative excess current. Synthesis of renewable fuels: Motor vehicles powered by renewable fuels (from CO2, hydrogen and regenerative electricity) are operated almost greenhouse gas neutral. Further development of the Power to Gas technology by collecting experience with large pilot plants.

Project impact: The methane (natural gas) for fueling cars with gas engines (Audi A3 g-tron) is produced as follows: CO2 from a biogas plant and hydrogen from water electrolysis are, via a catalytic process, converted into methane (natural gas) using renewable excess current.

Positive project assessment: 80-90 % of the worlds fossil raw materials are burned. The transport sector plays a major role in the CO2 emissions that are generated. Since the PtG-methane can be burned almost greenhouse gas-neutral, the PtG technology provides a valuable contribution to the reduction of CO2 emissions from the transport sector.

BASF - Argan program in Morocco

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Chemical Industry

Target Stakeholder/s:
Raw Material Producers, Governments

Summary:
Fairtrade between Germany and Morocco: Biologically produced Argan oil and its by-products have been delivered to BASF under fairtrade conditions since 2005.
Supplied through a Moroccan cooperative network. Social and economic development of the Moroccan region of Agadir through sustainable argan oil products. Due to this fairtrade relationship 1,000 women from rural areas in south-western Morocco have benefitted.

BASF "Trilon M" in dishwasher tabs

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Chemical Industry

Target Stakeholder/s:
Product Manufacturers, Chemical Industry, Consumer Associations

Summary:
Chemical Substitution - Phosphates in dishwashing tabs were replaced by Trilon-M (methylglycinediacetic acid, MGDA) formulations.

By employing Trilon-M, dishwasher tabs contribute far less to the eutrophication of water bodies. Trilon-M also protects the limited natural phosphate deposits (which are often contaminated with heavy metals, especially cadmium), which are used primarily for the extraction of phosphate fertilizers. The very powerful phosphates in dishwashers' tabs could be equivalently replaced by Trilon-M formulations. In contrast to phosphates, Trilon M has a lower environmental impact.

Best practice code for the application of anticoagulant rodenticides

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Consumer Associations, Governments

Summary:
This common best practice code for the application of anticoagulant rodenticides is legally binding in Germany and applies to all biocidal products containing anticoagulant rodenticides. The best practice code is available in different versions either for trained professionals, untrained professionals and amateurs. Any additional individual instructions for use, which apply to the relevant product, must be observed as well.

The common best practice code includes (1) general safety instructions, (2) planning and documentation, (3) application and servicing, (4) inspections and (5) preventive control measures. In addition, as a pre-condition to apply baits permanently, trained professionals have to check if non-chemical control or prevention measures (e.g. traps) can be used instead of rodenticides and the general public and (untrained) professionals have to consider non-biocidal methods to control rodents prior to the use of biocidal products.

Biocides - Proposal for a concerted European approach towards a sustainable use

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Consumer Associations, Governments

Summary:
The position paper “Biocides - Proposal for a concerted European approach towards a sustainable use” contains the conclusions of the Federal Environment Agency of Germany (UBA) from two research projects and the corresponding discussions dealing with the topic of a sustainable use of biocides. The objective of this paper was to provide the European Commission with the UBA conclusions and to encourage their consideration in the context of the report required according to Article 18 of regulation (EU) No 528/2012.

Covestro "Dream Production"

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Chemical Industry

Target Stakeholder/s:
Product Manufacturers, Brands, Raw material producers

Summary:
Carbon Capture and Utilisation (CCU): Commissioning of a production plant (5000 t / a) for CO_2-based synthesis of polyols which is a starting material for the synthesis of polyurethane flexible foams. A catalyst is being developed which makes it possible to use the slow reacting and low-energy CO2 as raw material for the polyol synthesis.

Covestro - Impact Technology for Polyol Synthesis

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Chemical Industry

Target Stakeholder/s:
Product Manufacturers, Chemical Industry

Summary:
Here a process simplification is presented by means of catalyst replacement for the synthesis of polyether polyols. Double metal cyanide (DMC) catalysis replaces the traditional potassium hydroxide (KOH) catalysis. Catalyst technology makes the production of polyether polyols significantly more sustainable. At the same time, the product quality also rises. From about 1950 to 2000, the KOH catalysis for the synthesis of polyether polyols was the industry standard worldwide. With the new impact technology (DMC catalysis), which can be installed relatively easily with existing KOH-based systems, Covestro has succeeded in establishing a new, significantly more sustainable industrial standard.

Guide on Sustainable Chemicals and IT-Tool Sub Select

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Governments

Target Stakeholder/s:
Brands, Consumer Associations, Product Manufacturers, Governments, Chemical Industry

Summary:
The Guide on Sustainable Chemicals and the corresponding IT-tool Sub-Select of the German Environmental Agency helps manufacturers, formulators and end users of substances to focus on sustainability aspects in the selection and use of substances in the company.

The Guide on Sustainable Chemicals merges a perspective on a substance's intrinsic properties and a perspective on the potential exposures of humans and the environment to evaluate sustainability. In addition to the guide with Sub-Select enables the users to assess and compare the sustainability of mixture based on the intrinsic properties of their components.

Kilian - functional substitution in label production

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Small and Medium Sized Enterprise

Target Stakeholder/s:
Product Manufacturers, Brands, Chemical Industry

Summary:
For the production of industrial labels, Kilian applies the etching technique. Certain parts of the labels are etched with chemicals. Those parts which are not etched are covered with bitumen. After the etching process, bitumen is removed with a solvent. Kilian used to use toxic tetrachloroethene as a solvent. In the context of this functional substitution, tetrachloroethene was replaced by fatty acid esters obtained by transesterification from coconut oil.

Tetrachloroethene is the most stable of ethane and ethene-chloro derivatives. It is stable against hydrolysis and the corrosion of metal surfaces is less pronounced than with other chlorinated solvents. Owing to these favorable properties, tetrachloroethene is very frequently used as a solvent in industry. Thus, the functional substitution described herein could be carried out for numerous further tetrachloroethene applications. The preparation of tetrachloroethenes is based on classical chlorochemical syntheses. These are very energy-intensive and lead to the formation of toxic waste.

The fatty acid ester mixture is obtained by transesterification of coconut oil with 2-ethylhexanol. The main component is 2-ethylhexyllaurate. The preparation of 2-ethylhexyl laurate largely corresponds to the principles of green chemistry. In preparation for this functional substitution, a chemical evaluation was carried out at Kilian with the German Environment Agency Guide on Sustainable Chemicals.

Nanomaterials and Sustainability

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Research Institution

Target Stakeholder/s:
Brands, Small and Medium Sized Enterprises, Chemical Industry, Product Manufacturers

Summary:
As part of the current debate on the opportunities and risks of nanotechnological applications, possible contributions to sustainable development is becoming increasingly controversial. It should be conducted on a more objective level. This objectification, however, can only be achieved on a case-specific basis, performing as quantitatively as possible a risk-and-benefit analysis targeted towards the total lifecycle. The methodological basis for such a systemic view, however, is still largely lacking.

Against this background, the Institute with the Nano-Sustainability Check (NNC), provides an instrument offering a systematic grid for an integrated approach relative to sustainability aspects of nanotechnological applications. With the help of the NNC, companies that develop or produce nanotechnological products and applications can carry out a self-evaluation of their own business activities. The aim of the NNC is to examine the sustainability of products and applications involving nanomaterials in terms of their practical advantages.

National Action Plan on Sustainable Use of Plant Protection Products

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Government, Consumer Associations, Raw material producers

Summary:
The National Action Plan on Sustainable Use of Plant Protection Products aims at reducing risks to humans, animals and the environment that can emerge through the use of approved plant protection products. The plan considers health, social, economic and environmental impacts.
The Action Plan was drawn up with the collaboration of the Länder and the participation of associations concerned with plants or plant products, plant protection, consumer protection, water management or environment protection and nature conservation. Taking into account previously implemented risk-reducing measures, the National Action Plan contains quantitative regulations, targets, measures, indicators and timetables for reducing risks and adverse impacts from the use of plant protection products on the human and animal health, as well as on the environment. The target requirements relate to plant protection, operator protection, consumer protection and protection of the environment.

PERO & SAFECHEM - Cleaning of metal parts

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Product Manufacturers

Target Stakeholder/s:
Government, Product Manufacturers

Summary:
With Chemical Leasing a new business model was applied by SAFECHEM and PERO Innovative Services that incentivized both companies to consume fewer chemicals for the process of industrial parts cleaning for an automotive supplier in Austria. Cleaning processes such as this are typical and widely used in industrial applications. Thus, this best practice case for sustainable chemistry has an enormous multiplication potential. Chemical leasing is a service-oriented business model that shifts the focus from increasing sales volume of chemicals towards a value-added approach. The producer mainly sells the functions performed by the chemical and functional units are the main basis for payment.

Prometho – Green Ink

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Product Manufacturers

Target Stakeholder/s:
Brands, Product Manufacturers, Raw Material Producers

Summary:
Functional substitution - Finite and hazardous raw materials for the manufacture of black ink have been completely substituted by renewable and non-hazardous feedstocks. Non-regenerative and hazardous raw materials, which were classified as indispensable for the production of black ink, could be completely replaced by renewable, non-toxic raw materials, which can be obtained from non-edible biomass.

The German Chemical Leasing Initiative

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Chemical Industry, Product Manufacturers

Summary:
In 2007, the German Federal Environment Agency (UBA) launched its first national chemical leasing project encouraged by the work of UNIDO Global Chemical Leasing Programme. The German project conducted Chemical Leasing pilot projects throughout multiple sectors of the German industry. A national working group with regular annual meetings has been established; a webpage including support functions and an exchange forum in German has been set up.

The International Sustainable Chemistry Collaborative Centre (ISC^3)

Submitted by:
Federal Environment Agency

Submitting Stakeholder Type:
Civil Society Organization

Target Stakeholder/s:
Innovators, Academic Institutions, Consumer Associations, Brands, Governments

Summary:
ISC^3 aims to shape the transformation of the chemical sector towards sustainable chemistry and thus contribute to a more sustainable world and a circular economy. The key principals of ISC3 to achieve transformation are as follows: Collaboration, Innovation, Education, Research and Information.

The Indicator set Parameters of Sustainable Chemistry (PSC)

Submitted by:
German Federal Environment Agency

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Chemical Industry, Product Manufacturers, Small and Medium Sized Enterprises

Summary:
This indicator set, Parameters of Sustainable Chemistry (PSC), is an indicator element addressing mainly processes and production. It enables the assessment of specific sustainability measures applied in enterprises. Therefore, the target group for the application of these indicators is enterprises which produce or use chemicals.
The PSC indicator set covers all major topics pertaining to Sustainable Chemistry.
It is based on six core criteria: (1) climate footprint, (2) impacts on the environment, (3) product design, (4) risks to health, (5) economic benefits and (6) transparency, training, social standards, dialogue and international cooperation.

Using Waste Carbon Feedstocks to Produce Chemicals

Submitted by:
U.S. International Trade Commission

Submitting Stakeholder Type:
Government

Target Stakeholder/s:
Academic Institutions, Research Institutions, Product Manufacturers, Government

Summary: This working paper:
1) explains carbon's critical role in the production of chemicals and as a target for industrial emissions reduction.
2) describes new CCU technologies stemming from advances in fields such as industrial biotechnology and electrolysis.
3) identifies sectors and geographical locales in which these technologies are being adopted, as well as factors driving adoption.
4) examines potential implications for U.S. and global industrial competitiveness within one sector with high emissions, the steel industry.

Banyan Nation start-up – promoting plastic waste management.

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovators / Start-Up Companies

Target Stakeholder/s:
Waste and Recycling, Governments, Raw Material Producers, Product Manufacturers

Summary:
Banyan Nation (start-up) is changing the way the country sees and understands plastic recycling. With the help of a comprehensive data tracking system that maps this informal sector, Banyan works with local waste collectors to produce near-virgin grade plastic granules that it sells to leading manufacturers in a variety of sectors. By doing so, Banyan introduces sustainable industrial methods, protects aquatic environments, and promotes sustainable and inclusive communities.

Checkerspot Start-up biomanufacturing

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovators / Start-Up Companies

Target Stakeholder/s:
Academic Institutions, Research Institutions, Product Manufacturers, Small and Medium Sized Enterprises.

Summary:
Checkerspot breeds and optimizes microbes able for use in the biomanufacturing of unique structural oils. It mainly addresses UN SDGs 7, 12, 13,

Chemical knowledge combined with technological and architectural knowledge applied to the global construction sector for increased awareness around sustainable building materials.

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Civil Society Organization

Target Stakeholder/s:
Consumer Associations, Product Manufacturers, Chemical Industry, Governments

Summary:
Hundreds of years ago, before fungicides and biocides were known, a proper construction and carefully selected building materials were used to build houses, temples, and palaces. Nowadays experience from the past and advanced chemical knowledge combined with technological and architectural knowledge can be used in order to prevent water access to buildings facades (e.g., prudent construction), enable quick drying of the facade and select humidity-, fungi-, algae-resistant building materials instead of applying environmentally harmful fungicides and biocides.

CIBIOT at Universidad Pontificia Bolivariana: how green chemistry biotechnological projects can be transformed towards sustainability

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Raw Material Producers, Academic Institutions, Civil Society and Non-Governmental Organizations

Summary:
A project of the biotechnology research group CIBIOT at Universidad Pontificia Bolivariana is about the development of a competitive and scalable process for gold extraction using biotechnology as a substitute for environmentally harmful mercury or cyanides.

The authors of this study do not describe the biotechnological process into detail but does provide information about reduced environmental impact from the biotechnological method. This green process

is more efficient than the conventional one and the wastewater can even be reused in a significant percentage.

In addition to changing the conventional process into a green one, two doctorate courses in engineering were established to educate young researchers in biotechnology and two business models were assessed for bringing the technology into practice in the local communities. One business model is about selling the substance used in this biotechnological process to the miners, the other model seeks to implement the process into the existing infrastructure of the communities. Both activities represent capacity building measures. Part of the project also implied o involving miners by interviewing them as well as field trips for raising acceptance for this new technology and strengthen its implementation. This example clearly illustrates that by including educational and economic aspects addressing the social and economic dimensions of sustainability, green chemistry projects can be expanded towards sustainable chemistry.

INDRESMAT start up in Spain for the building sector

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovator / Start-up Companies

Target Stakeholder/s:
Consumer Associations, Product Manufacturers, Governments

Summary:
INDRESMAT harvests the potential of thermoset polyurethane (PUR) to produce more energy efficient and carbon-friendly construction materials. INDRESMAT develops polyurethane resins that are versatile, durable, recyclable, and sourced from renewable raw materials, mainly vegetable oils and lignin. This enabled market implementation of sustainable building materials, such as frames for windows and doors and insulating foam coatings, that have high resilience and insulation levels, ultimately conserving energy and reducing carbon emissions. The company's mission mainly addresses SDG 9, 11, 12, 13.

Innoverda start-up in France for transforming the chemical production sector

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovator / Start-up Companies

Target Stakeholder/s:
Chemical Industry, Academic Institutions, Research Institutions

Summary:
Innoverda is a French start-up that identifies potential pathways for electrochemical production. This approach offers an alternative to traditional industrial processes, and can significantly reduce the inputs of energy, toxic and corrosive substances, non-renewable raw materials, and high pressures and temperatures.

The electrosynthesis processes developed and explored by Innoverda, particularly flow electrosynthesis, have the potential to transform the pharmaceutical and chemical industries. Innoverda offers this expertise to manufacturers, testing if traditional processes can be improved by their electrochemical approach. The company's approach strives to address SDGs 3, 9, 12, & 13.

LeafyLife - Start-up in Kenya valorizing sanitary product waste.

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovator / Start-up Companies

Target Stakeholder/s:
Waste and Recycling Sector, Raw material producers

Summary:
LeafyLife turns waste diapers and sanitary pads into alternative non-toxic fuel. This start-up strives to address SDGs 1, 7, 13, 15.

Le Qara - Start-up for sustainable processing in the textile industry

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovator / Start-up Companies

Target Stakeholder/s:
Chemical Industry, Product Manufacturers

Summary:
Le Qara brings sustainability and circularity into the leather industry, which is the fourth most polluting industry in the world. They have designed a production process based on microorganisms that creates high-quality, biodegradable, and vegan leather, and which results in less waste and use of toxic chemicals. The company mainly addresses SDGs 3, 6, 12, & 14

Mobius- A start up in the USA making sustainable alternatives to single-use plastics

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovator / Start-up Companies

Target Stakeholder/s:
Recycling and Waste Sector, Product Manufacturers, Brands, Chemical Industry

Summary:
Mobius is innovating breakthrough technologies that have the potential to transform the plastic and polymer specialty chemical industries. They have developed a family of naturally degradable and compostable polymers made from lignin, a by-product of the paper and biofuel industries. These polymers are used to create plastic products that serve as a sustainable alternative to single-use and petroleum-based plastics, thus contributing to the Sustainable Development Goals (SDGs) 12, 13, 14, & 15

New global sustainable business models – Chemical Leasing

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Product Manufacturer, Chemical Industry

Summary:
Chemical leasing can serve as a new global model for chemical sales as it is in line with sustainable chemistry's system thinking and contributes to sustainable chemistry by offering the customers a service - albeit based on chemicals - on a commercially viable way, thereby reducing resource depletion and environmental pollution. Customers pay for the service provided by chemicals instead of the tonnage of chemical such that advanced chemical knowledge is used to develop individual, effective solutions for specific purposes. In this way the responsibility of the manufacturer is extended to the whole life-cycle of the chemicals needed for delivering a required function or service. At the same time the manufacturer is also interested in using less and nontoxic, easily reusable or recyclable chemicals and materials to meet the extend of service needed.

Leuphana University of Lüneburg and Schülke GmbH conducted a research project focusing on maintaining hygiene standards in a hospital instead of just selling and applying disinfectants. Hygiene status before and during the project were monitored by the microbiological tests and infection rates. The results demonstrated that sharing the producer's knowledge about the proper handling and applying of disinfectants lead to 60% reduction of the disinfectants needed to maintain high hygiene standards.

Another example of a successful implementation on chemical leasing contributing to sustainable chemistry is demonstrated by the example of SAFECHEM. The company provides solutions for the safe and sustainable use of solvents for cleaning industrial parts, textiles and asphalt testing applications. The

company collaborates with numerous partners (including distributors and customers) in order to collect the knowledge necessary for providing better performance out of chemical products, to use them for longer and to be able to recycle them afterwards.

Another example of chemical leasing is found in industrial parts cleaning in which square meters of varnished metal sheet is sold instead of tonnage of varnish.

Reduce, Repair, Reuse, Recycle and Circular economy FAIRPHONE caste study.

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovator / Start-up Companies

Target Stakeholder/s:
Brands, Consumer Associations, Product Manufacturers

Summary:
Reduce, Repair, Reuse, Recycle and Circular economy are approaches which contribute to sustainable chemistry by preserving resources and reducing waste. However, it requires a change in the mind-set and habits of customers (e.g. using the product longer instead of disposing it after a short while) and a rethinking of the product design with regard to sustainable chemistry by the producers (design for repair, reuse, recycle) for example by reducing the products' complexity.

FAIRPHONE is a start-up striving towards the transformation of the electronic industry towards sustainability. The producer offers long-lasting smartphones, designed to be easily disassembled in order to be repaired (spare parts and respective tutorials for self-repair are available) or recycled. The company also seeks for responsibly acquired resources from suppliers respecting human rights and workers' safety.

Reducing plastic consumption on a global level – A review.

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Academic Institutions

Target Stakeholder/s:
Consumer Associations, Academic Institutions, Brands

Summary:
In this paper by Professor Klaus Kummerer an overview of the multiple ways of implementing sustainable chemistry, some of which are very simple solutions which and are already in place is presented.

For example, the easiest way of reducing plastic consumption is avoiding the use of plastic packaging for food and disposable plastic bags. Knowledge of food chemistry provides an opportunity to avoid

plastic packaging by proper storage and handling of the products. Instead of plastic packed products, customers are encouraged to choose products sold by weight (especially fruits and vegetables) and use their own reusable bags. Such an approach contributes to decreased plastic production as well as preventing the generation of huge amounts of non-biodegradable waste.

Andes Bioenergy – Start up - founded by Mario Salgado, winner of the Elsevier-ISC3 "Entrepreneurial Spirit in Sustainable Chemistry Award" - Using the P-SMART (pyrolysis small and modular auger reactor) technology to up-cycle agro-industrial biomass waste.

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Innovator / Start-up Company

Target Stakeholder/s:
Waste and Recycling Sector, Raw material producer, Chemical Industry, Product Manufacturers

Summary:
The P-SMART technology turns bio-waste into biochar and gives small-scale agro-industries the opportunity to become (early-stage) biorefineries. The service is particularly relevant for small and medium scale agro-industrial facilities (such as cocoa, coffee, corn, and rice processing centres) in developing countries.

The P-SMART reactor enables the refinement of agro-industrial biomass waste to charcoal products such as biochar and renewable thermal energy. Currently, agro-industrial biomass waste is hoarded on field sites, which endangers the quality of the surrounding environment, releases significant CO_2 and CH_4 emissions, contaminates groundwater by leaching and attracts airborne vector-borne diseases. The agricultural use of biochar produced from biomass waste may alter soils potentially contaminated with heavy metals. The use of biochar can also restore eroded soils, reduce the use of fertilisers and irrigation water, increase drought tolerance and crop yields, while the thermal energy produced would reduce energy costs and greenhouse gas emissions associated with the burning of fossil fuels currently used to generate heat in agro-industrial plants.

An approach for more efficient thermal insulation of buildings

Submitted by:
International Sustainable Chemistry Collaborative Centre (ISC3)

Submitting Stakeholder Type:
Academic Institution

Target Stakeholder/s:
Consumer Associations, Academic Institutions

Summary: In this paper by professor Klaus Kummerer an overview is provided of how thermal insulation of buildings and other measures can be applied to save energy and thereby CO_2 emissions. A reduction in amount of insulation materials is possible if the desired ambient temperature should be 20C

or 21C. The same is the case for the summertime - reducing ambient temperature not to 19C by air conditioning/insulation but to 23 C or 24 C would save much material (and energy).

By considering small but sustainable changes, chemical industry could offer such a well-balanced package of insulation products and advice.