Sustainable Chemistry – a Concept with Beneficial Links to Waste Management

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FORWARD TOGETHER
UNITING IDEAS FOR SUCCESSFUL WASTE MANAGEMENT SOLUTIONS

ISWA World Congress
Novi Sad 2016. Serbia



- The Sustainable Chemistry Concept
- What can be achieved on the basis of sustainable chemistry?
  - Examples
  - Improvements and setbacks
- Forwarding sustainable chemistry: The ISC$_3$ project

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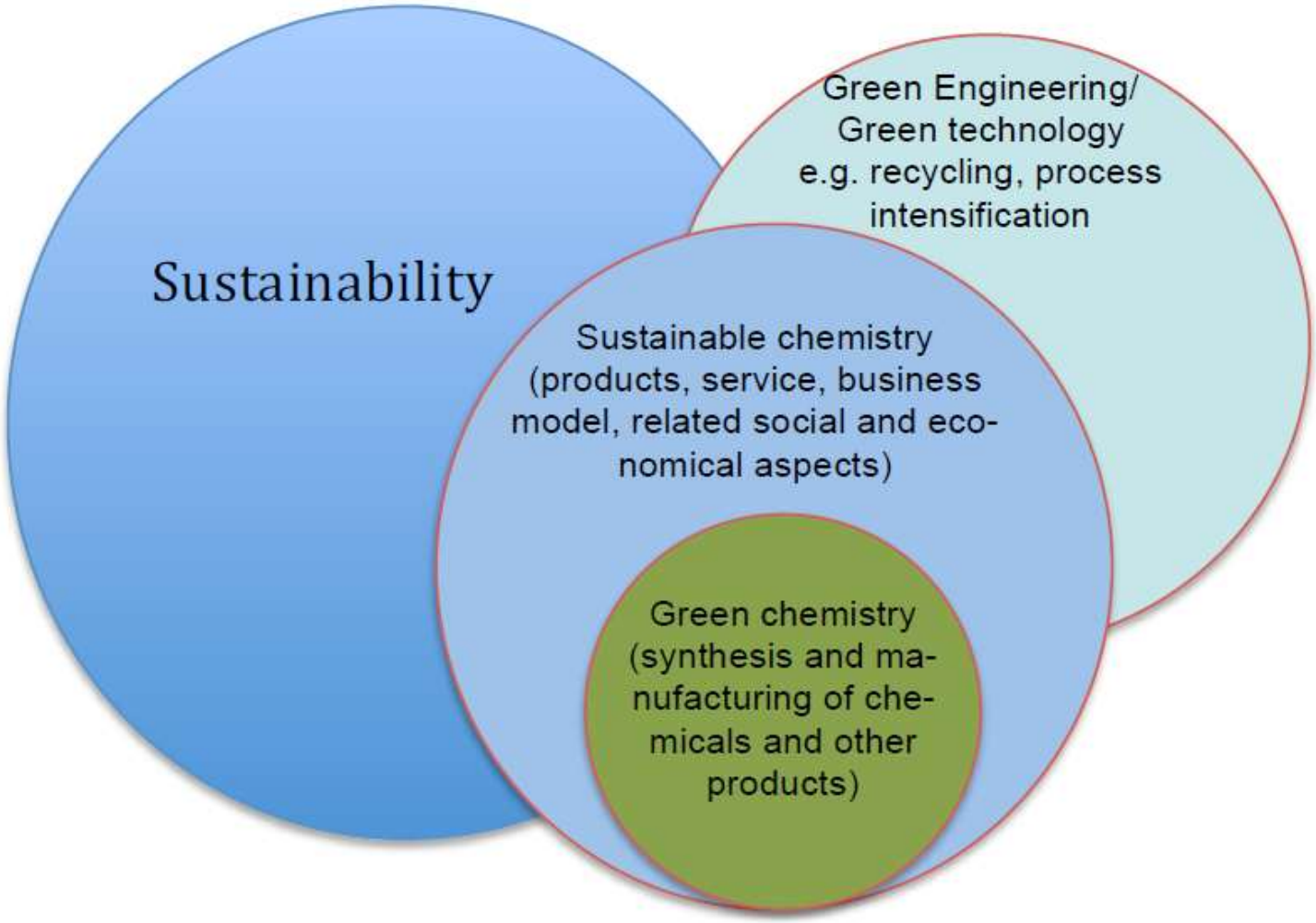
The Sustainable Chemistry Concept

Sustainable Chemistry is a concept, not a cookbook:

- **Use the principles of Green Chemistry as basis on the molecular level**
- **Make your assess-ments in an inter-disciplinary manner.**
- **Integrate the end of life of your product into its development.**
- **Communicate with all stakeholders in the value chain.**



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Ideas and goals behind the Sustainable Chemistry concept

- Supporting positive, long-term development
- Providing value-creating products and services (by new products and technologies).
- increasing use of substances, materials and processes with the least possible adverse effects
- Providing recycling concepts
- Conserving natural resources
- Avoiding damage to human beings, ecosystems and resources
- Based on a holistic approach

(abbreviated version of „Sustainable Chemistry in 100 words“, Umweltbundesamt, Dessau, 2016)



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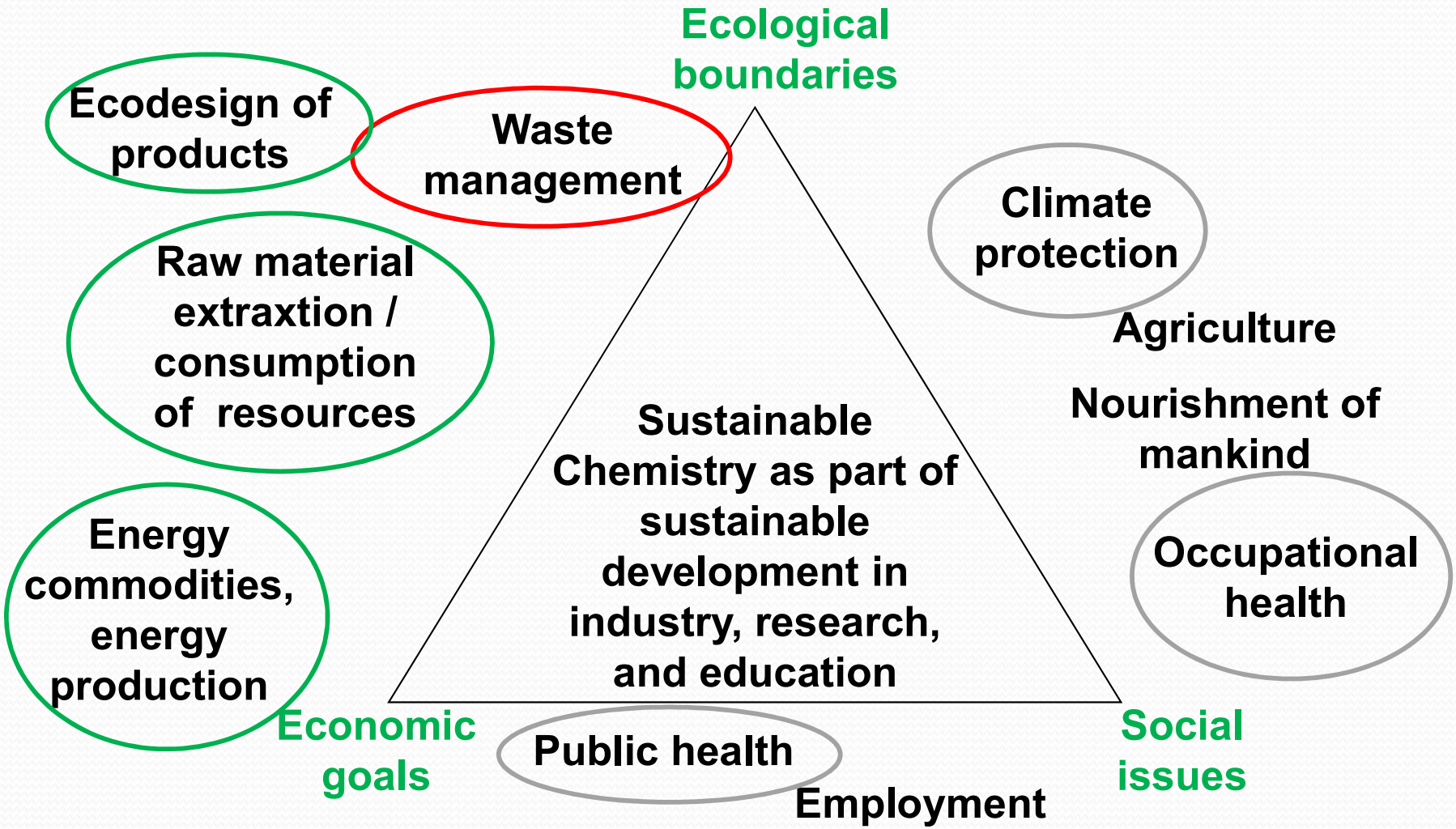
Sustainable Chemistry is an opportunity interfacing other global issues



Chemicals and Waste: The UNEP perspective

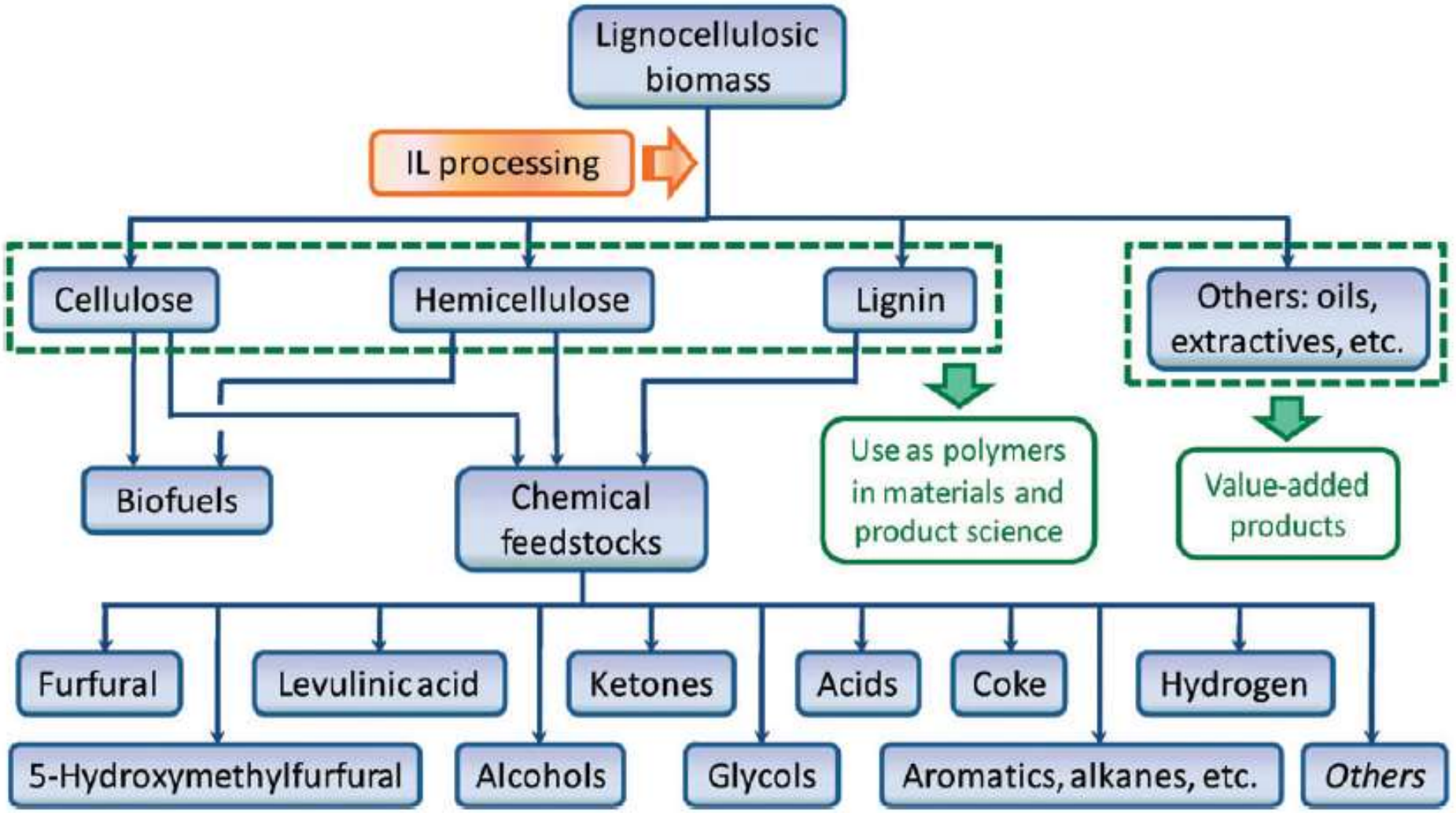
"A major challenge is to nurture a new way of thinking and attitude change at all levels in order to move away from a silo approach and address chemicals and waste issues in an integrated way as part of a broader development agenda."

Integrated National Implementation of SDGs and International Chemicals and Waste Agreements - Key Messages and Insights
International Expert and Stakeholder Workshop (organized by UNEP, UNITAR, BRS Conventions Secretariat), Geneva, Switzerland, 11-13 April 2016

Example No 1: Optimizing the atom economy of chemical synthesis = less waste

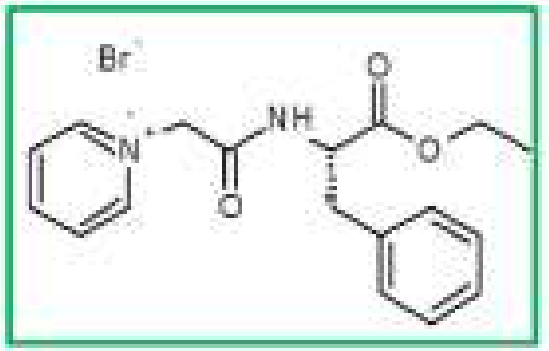
- **Long-standing development of heterogenous catalysts**
  - **Highly specific reaction paths**
- **Syntheses of special chemicals in small amounts**
  - **using nanotubes as reaction vessels**
- **Tailor-made ionic solvents**
  - **decomposition of complicated biological molecules like lignocellulose with the aim to synthesize new platform chemicals**

Example No 1.1: Combining new chemical reagents and biomass – chance for biorefinery



Example No 1.2: From „classical“ ionic solvents towards sustainable ionic solvents

- **Ionic solvents**
  - **Highly specific reaction pathways leading to an excellent ratio between product and input material**
  - **Recovery of ionic liquids from the reaction process is mostly possible**
  - **But ionic liquids are often toxic and not biodegradable, e.g. imidazolium cations**
- **Sustainable solution: Ionic liquids constructed for bond cleavage under environmental conditions**
  - **Based on phenylalanine diethylester**
  - **Completely mineralizable**
  - **Gathergood, Kümmerer et al. Green Chem. DOI: 10.1039/c6gc00417b (2016)**

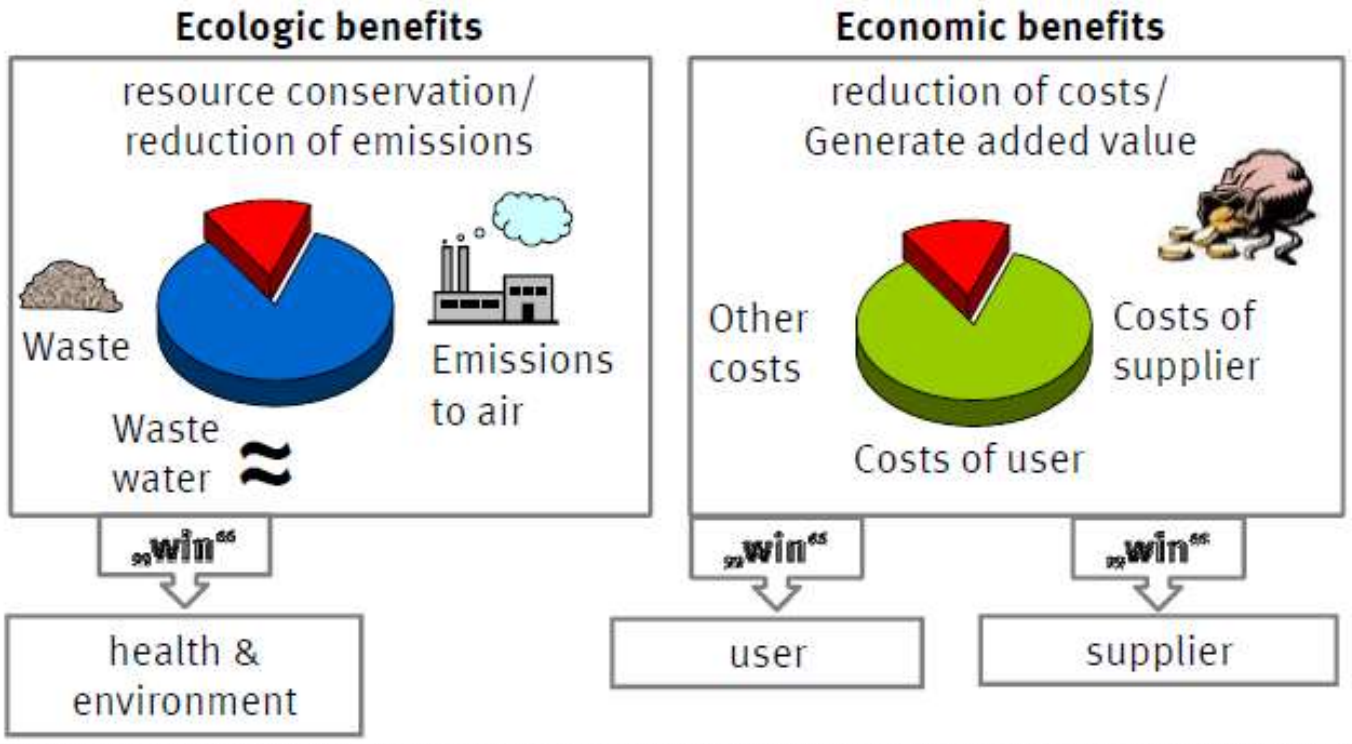


Example No 2: Use of renewable and/or secondary resources = resource conservation

- **Tree barks (esp. Eucalyptus)**
  - **No use, use as mulch, energy from incineration…**
  - **Triterpenoids isolated from bark**
  - **Flavonols and phenolic acids synthesized from tannins**
- **Sewage sludge**
  - **Use as fertilizer with poor mobilization of phosphorus**
  - **RecoPhos®: Recovery of up to 98% of phosphorus directly via MAP without complicated dewatering processes**
- **Plastic waste**
  - **Recycling of polymer (often low quality)**
  - **Depolymerisation: Nylon 6 → Caprolactam; PET → Terephthalic acid (high quality)**

Example No 3: Sell a service instead of a product = less waste, better business

- **Focus on the benefits, not the possession of chemicals**
- **Optimize the efficiency of the use of chemicals**
- **Bring economic and environmental interests togehter**
- **Payment for successful service, not for the amount of chemicals used**



Source: Umweltbundesamt, (Federal Environment Agency)

Example No 3.1: Reduction of waste for the production of metal parts for car industry

Example: (UNIDO report)

- Cleaning of metals parts with a solvent (PCE): high emissions to air, risk for occupational health, 25 t waste / yr.
- Cooperation of the producer (FKL, Serbia) with a chemical leasing provider (SAFECHEM Europe) and a manufacturer of high quality cleaning machines (PERO, Germany)
- Use of PCE stabilized against acidification; redistillation on site; hermetically closed cleaning procedure
- 1,5 t / yr. waste, emissions close to zero, 70,000 € / yr. saved

- Promotion by UNIDO via regional centres (e.g. Serbia)
- Numerous examples worldwide

What can we achieve by practising sustainable chemistry with respect to waste management?

- Waste minimization due to better processes
  - in the chemical industry
  - in other branches using high amount of chemicals
- Design of products also covering aspects of recycling
  - in the complete value chain
- More use of renewable resources
  - based on isolated chemicals from industrial waste
  - based on new platform chemicals from natural origin
- More use of secondary raw materials
  - higher quality of resources from waste necessary
- Less hazardous waste, less risks for occupational health

SDGs 7 and 12: Great challenges to be met!

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all	- Advanced materials for renewable energy (PV, wind, batteries, supercapacitors…) - Chemical energy storage - Materials for energy efficiency in coatings…)	SDG 12: Ensure sustainable production and consumption patterns	- Resource and energy efficient chemical production - Closing material cycles recycle or higher biodegradability

Mixed up materials, highly complex products ↔ difficult collection of wide spread products, lack of technology for separation of composite materials, not enough communication in the value chain

What can we not achieve with sustainable chemistry? We cannot solve…

- **The entropy dilemma i.e. mixture of several materials in one product leading to complicated and energy consuming recovery processes:**
  - ***Mitigatio***
  - ***Contrasti*** ***gn***
- **The dissipa** **s being an obstacle fo**
  - ***Mitigatio***
  - ***Contrasting development: Growing prosperity worldwide.***
- **The double role of waste and valuables, i.e. contamination of used items containing valuable resources by dangerous compounds**
  - ***Mitigation by the "benign by design" principle***
- **Time lag between the production of a good and its final fate as waste:**
  - ***No solution. From our experience, toxicity assessments normally get worse by time.***

Complete circular economy and absolute chemical safety are only promised by witch doctors



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Sustainable Chemistry is on the international agenda!

UNEA Resolution 2-7 „Sound management of chemicals and waste“ urges UNEP to analyse the opportunities of the sustainable chemistry concept „including linkages to sustainable consumption and production policies and the possibilities that sustainable chemistry may offer to contribute to the achievement of the 2030 Agenda…”

In 2017, the International Sustainable Chemistry Collaborative Centre will be launched. The project is promoted by the German government (Ministry for Environment and Building and Federal Environment Agency). ISC_3 will install a global network for sustainable chemistry - ISC_{net}

Scope of the ISC_3 project

- Concept of Sustainable Chemistry to be established
  - Development in science and industry
  - Consolidation of basic ideas, especially interfaces…
  - Sustainable management of material flows and product design
  - Teaching S
- How to proce inable Chemistry?
  - Tool to for ss post 2020
  - Becoming each the SDGs
- Collection, promotion, and dissemination of successful business models
  - Win-Win situation achievable for industry
  - Opportunities for developing countries
- Positioning Sustainable Chemistry as a tool to keep within the „planetary boundaries“

ISC3
International Sustainable Chemistry Collaborative Centre

How to become a part of the International Sustainable Chemistry Network - ISCnet?

Visit www.isc3.org

Please use the contact form!

Your comments and suggestions are welcome!

Remain on track with the development of the Centre and the Network

Conclusion

- **The Sustainable Chemistry Concept offers an holistic view including important tasks of waste management**
- **If more products should be recycled and more materials recovered for further use on a high level, sustainable chemistry approaches can be very helpful for waste management**
- **Stakeholders from the waste community will benefit from co-working with ISC$_3$ and ISCnet to focus the attention of stakeholders from the chemical industry and reseachers on the EoL problem of materials and products**



Thank you for your attention

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