

OFFICIAL JOURNAL OF THE **INDIAN CHEMICAL COUNCIL**

VOL. XVII | APRIL 2021 | NO. 10 | PAGES 86 | ANNUAL SUBSCRIPTION RS.1,500/- | PRICE PER COPY RS.150/-

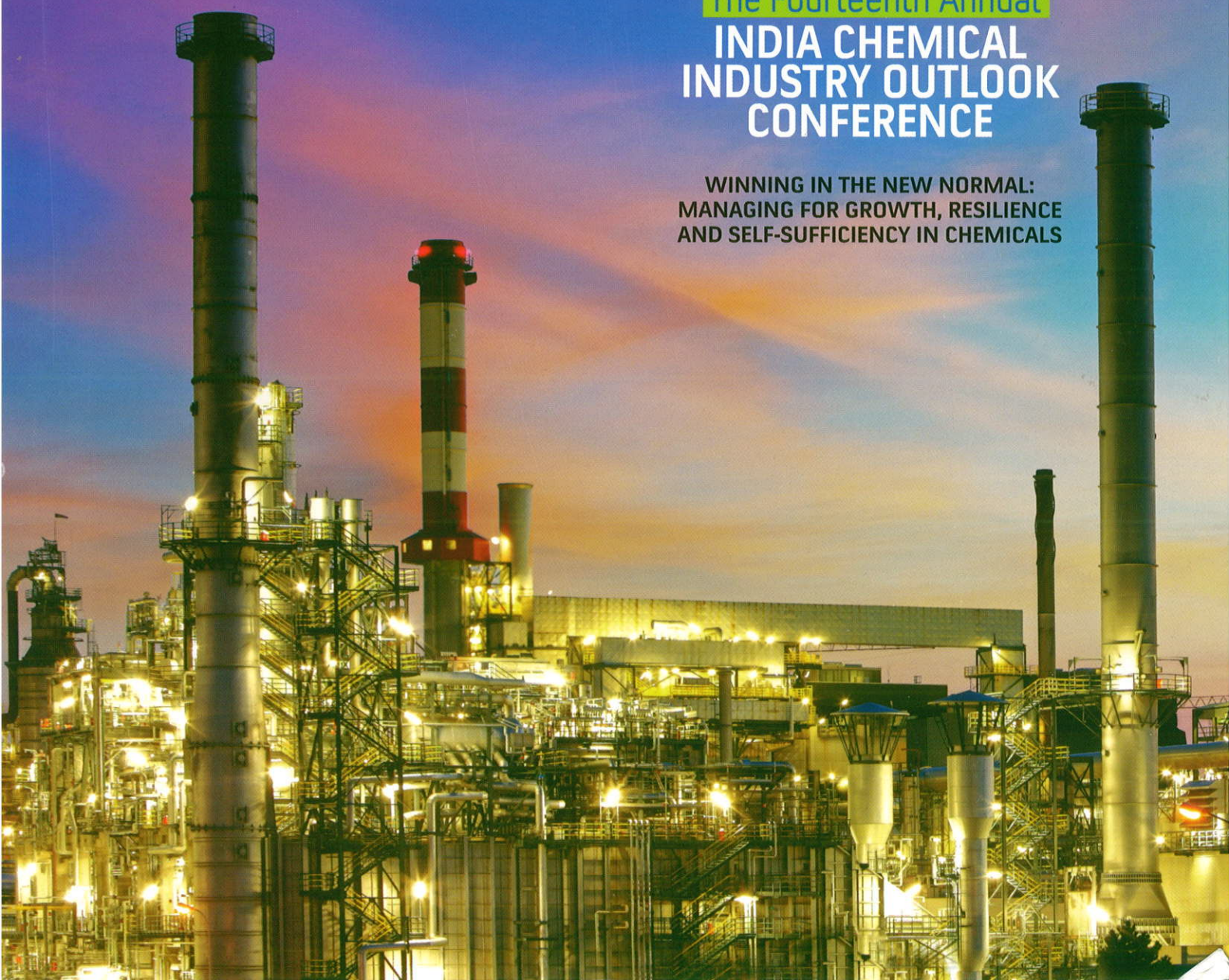
# CHEMICAL NEWS



## 14th

The Fourteenth Annual  
**INDIA CHEMICAL  
INDUSTRY OUTLOOK  
CONFERENCE**

**WINNING IN THE NEW NORMAL:  
MANAGING FOR GROWTH, RESILIENCE  
AND SELF-SUFFICIENCY IN CHEMICALS**





### Prof. Klaus Kümmerer

Klaus Kümmerer is Director of the Institute of Sustainable and Environmental Chemistry and holds the chair of Sustainable Chemistry and Material Resources at the public Leuphana University Lüneburg (Germany). He is Director Research and Education of the International Sustainable Chemistry Collaborative Centre (ISC3) in Bonn (Germany) too.

His research and teaching is focused on Sustainable Chemistry, Sustainable Pharmacy, Material Resources, Aquatic Environmental Chemistry, and Time in Environmental and Sustainability Research. He received national and international awards for his interdisciplinary work. Klaus Kümmerer serves and served in national committees (e.g. German Research Council's Senate Commission for Water Research, Board of the Division of Sustainable Chemistry of German Chemical Society) and international ones including Global Chemical Outlook by UNEP, the EU Technology Platform SusChem Europe and IUPAC Interdivisional Committee on Green Chemistry for Sustainable Development (ICGCSD).

Prof. Kümmerer is advising international organisations such as UNEP and WHO and companies. He is also scientific chair and co-organizer of the annual interdisciplinary Green and Sustainable Chemistry Conference and the annual Summer School on Sustainable Chemistry in International Cooperation. He is founding editor and editor-in-chief of Sustainable Chemistry and Pharmacy, and Current Opinion in Sustainable Chemistry journals as well as associate editor of Chemosphere and Environmental Pollution. He published extensively in international scientific peer reviewed journals and co-edited more than 10 scientific books.

ICC in cooperation with International Union of Pure and Applied Chemistry (IUPAC) organised a Talk by Prof. Klaus Kümmeler on "From Green Chemistry to Chemistry in a Circular Economy to Sustainable Chemistry" on 18 January 2021. Detailed report on the Talk was published in the February issue of CHEMICAL NEWS. Now we have pleasure to reproduce the presentation made by Prof. Kümmeler for the benefit of our readers.

### From Green Chemistry To Chemistry in a Circular Economy To Chemistry for Sustainability

Prof. Dr. Klaus Kümmeler

International Committee on Green Chemistry for Sustainable Development (ICGCSD)

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www.leuphana.de/institut/ist/icc.html

https://iupac.org/who-we-are/committees-panels/icc.html

body\_code=041.html

Research and Education  
Informational Sustainable Chemistry Collaborative Center  
www.isc3.org



### INTERDIVISIONAL COMMITTEE ON GREEN CHEMISTRY FOR SUSTAINABLE DEVELOPMENT (ICGCSD)

#### Standing Committee Chair

Pietro R. Tundo

#### Titular Member

Jonathan Forman  
Klaus Kümmeler  
Natalia P. Tarasova

#### Associate Member

Florent Allais  
Aurelia Sorina Visa  
Jane Wissinger

#### Standing Committee Secretary

Buxing Han

The EXPERTS in GREEN CHEMISTRY and SUSTAINABLE DEVELOPMENT are concentrated in the ICGSD committee

Strong interdivisional support:

1. Supporting the other divisions/Committees
2. Valuable as a reference point/resource

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### METRICS FOR GREENER SYNTHESIS Project No.: 2017-030-2-041

#### Task Group Chair

Pietro R. Tundo

To develop Green Metrics and harmonize the correct application of green metrics analysis in syntheses

Introduction, Green Metrics, Glossary and Algorithm Database List

#### Members

Fabio Arico  
James Clark  
Marco Eissen  
Dieter Lenoir  
Peter Licence  
Nikolay E. Nifantiev  
David Smith  
Helen Sneddon  
Ronald Weir

#### Partners

Physical and Biophysical Chemistry Division  
Inorganic Chemistry Division  
Organic and Biomolecular Chemistry Division

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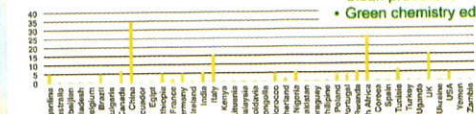
### GREEN CHEMISTRY LIVE AND ONLINE POSTGRADUATE SUMMER SCHOOL 4th-10th July 2021 Venice, Italy

An example of our interdivisional work:  
<https://www.greenchemistryschool.org/privacy-policy/>



The Summer School breadth of topics:

- Benign synthesis routes
- Green catalysis
- Alternative solvents
- Renewable and green raw materials
- Green chemistry for energy
- Clean processes
- Green chemistry education



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### The "Success" Story of Chemical Industries

- 350,000 chemicals/mixtures globally marketed (Wang et al., Environ. Sci. Technol. 2020, 54, 2075-2084)
- Thereof approx. >> 30,000 environmentally relevant, products of incomplete degradation not included (Umweltbundesamt, 2019)
- Hazardous to health 62 % of chemicals volume used in Europe 2016 (Source: European Environmental Agency)
- Ca. 1.6 mill. deaths in 2016 attributable to chemicals, many more affected (Source: World Health Organization)
- Neurological behavioural disorders caused by chemicals: Costs >170 Bill. US \$ per year in EU (Source: UNEP Environment 2019)
- Several hundred synthetic chemicals present in humans (Source: UNEP Environment 2019)

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### Green Chemistry

Focus on synthesis and properties of chemicals

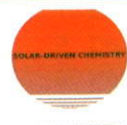


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### "Solar Chemistry"



- Photochemistry and Photo catalysis
- Organic Photo voltaics and Dye-Sensitized Solar Cells
- Light-driven Mechanisms
- Photo electrochemistry and Photochemical Devices
- Energy Storage

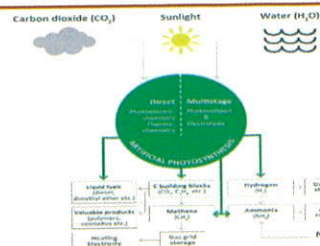


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### CO<sub>2</sub> as a Resource



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### Synthesis with Less Waste & Less Energy (Micro)flow Chemistry

- Less safety issues
- Less waste
- In situ generation and reaction of hazardous reactants
- More flexibility

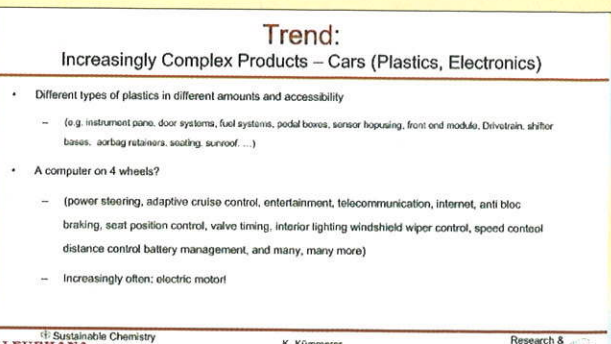
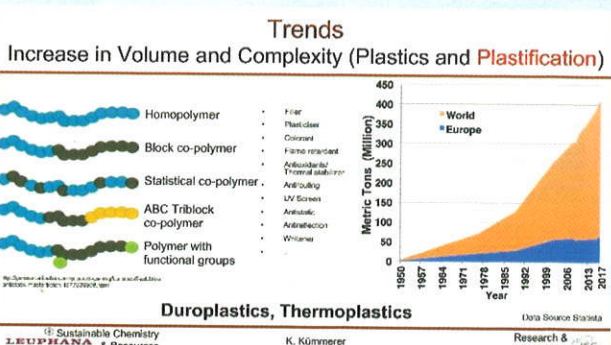
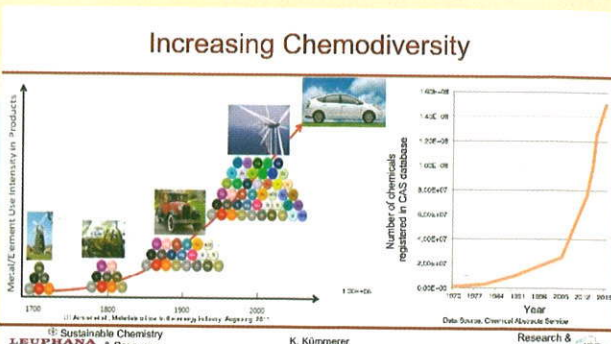
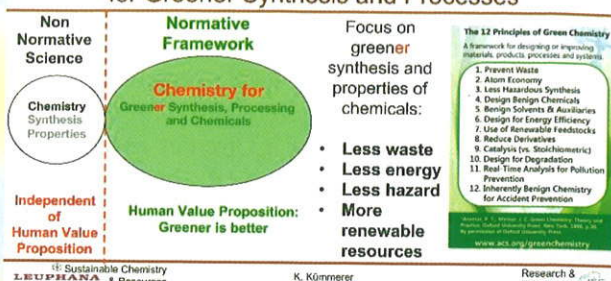
Also in combination with electro chemistry and photo chemistry

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## A Framework for Chemistry for Greener Synthesis and Processes





## There is no Endless Recycling! (Interim Conclusion)

- Unavoidable losses
  - Quantity
  - Quality
- Need of energy ->see Thermodynamics
- Increase of entropy! ->see Thermodynamics
- Pollutants!
- Not all chemicals and products can be circulated!

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## Thermodynamics 3 laws

1. You cannot win, you can **only end up in a draw**
2. You can only end up in a draw **at perfect conditions**
3. You will **never reach** perfect conditions

Summarizing:

We cannot win, we can only try to loose as little as possible

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What is needed!

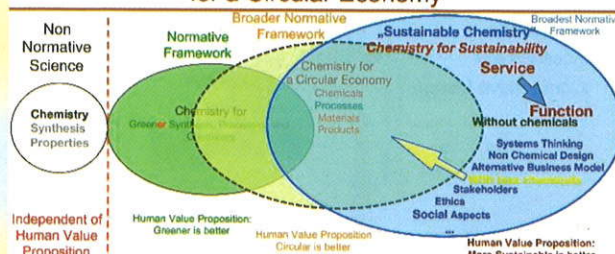
**Systems Thinking**

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## A Framework for Chemistry for a Circular Economy



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## What Is Sustainable Chemistry?

Angewandte Chemie

GDCh

A Journal of the Gesellschaft Deutscher Chemiker

Explore this journal >

Editorial

### Sustainable Chemistry: A Future Guiding Principle

Prof. Dr. Klaus Kümmerer

Angew. Chem. Int. Ed. 2017, 56, 1620 - 1621

Not a "state"

Not just optimization of individual chemical products, instead **functionality and service**

Not a new discipline, instead **across all sub disciplines of chemistry**

**Going beyond chemistry (science, industry) including application, ethics etc.**

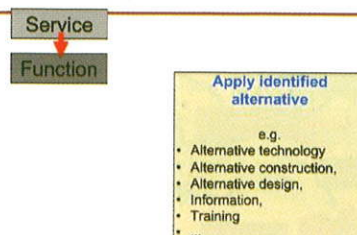
As for key characterisation see: <https://www.ac3.org/about/tech/sustainable-chemistry.html>

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## New Thinking: Sustainability, Chemistry and the Role of Chemists



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## Simple Example: Different Technology



No metal staples needed,

Instead punched paper from the sheets

Much easier to untile:  
no special tool needed,  
no metal wasted

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## Packaging ?



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## Same Service with Less



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## Function Biocides in Façades vs. Wise Design

- Wet façades suffer under growth of algae and fungi
- Application of a fungicide/biocide results in introduction of these compounds into surface water and potable water reservoirs (Hensen et al., Water Research 144 (2018) 413-423)
- Better/alternative approach:
  - Information and Education of architects, investors, craftsmen
  - Suitable construction (no/reduced access of water)

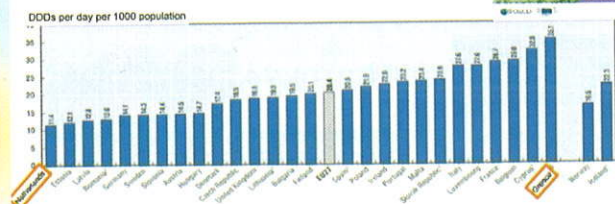
Prudent construction-no need for a fungicide:  
Façade is dry or can dry immediately and is resistant to fungi and algae

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## Use patterns (DDD per 1000 people) Antibiotics 2011(only reimbursed share)



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## Chemical Leasing

A service-oriented business model that shifts the focus

- from increasing the sales volume of chemicals (\$/kg)
- towards a value-added approach (\$/functional unit)

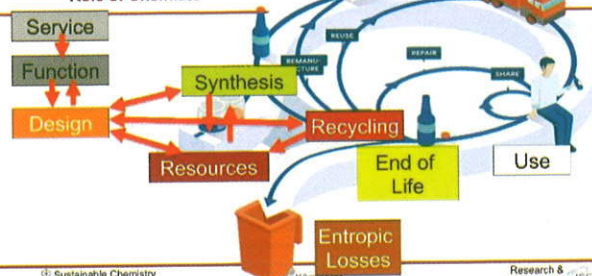


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## New Thinking: Sustainability Chemistry and the Role of Chemists



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## Conventional and Green Chemistry vs. Sustainable Chemistry

- **Old Model: Tonnage**  
Product for value creation-supply driven
- **New Model: Service**  
Service/functionality/performance for value creation  
- demand driven

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## Conventional and Green Chemistry vs. Sustainable Chemistry

- **Old Model: Tonnage**  
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A smart person solves a problem.

A wise person avoids it.



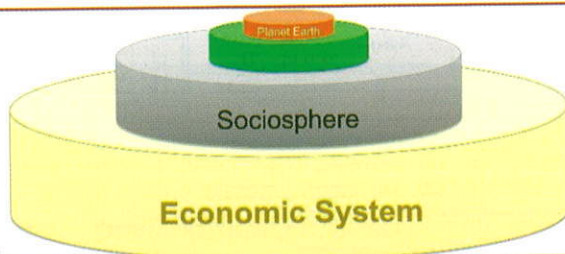
Attributed to Albert Einstein

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## The nowadays' perception



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## The Basis of All



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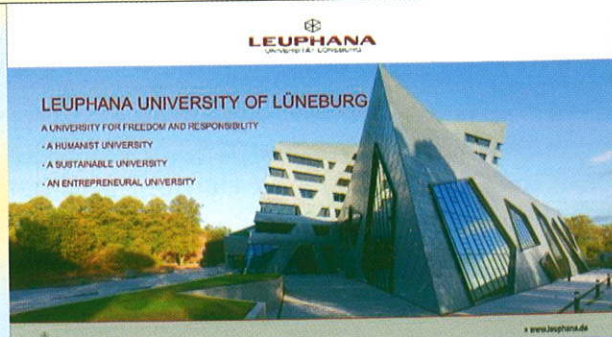
## Chemistry involved: 14 out of 17; 29 Targets



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UNIVERSITY OF LÜNEBURG  
A UNIVERSITY FOR FREEDOM AND RESPONSIBILITY  
• A HUMANIST UNIVERSITY  
• A SUSTAINABLE UNIVERSITY  
• AN ENTREPRENEURIAL UNIVERSITY

www.leuphana.de

## Lüneburg, Germany (50 km South of Hamburg)



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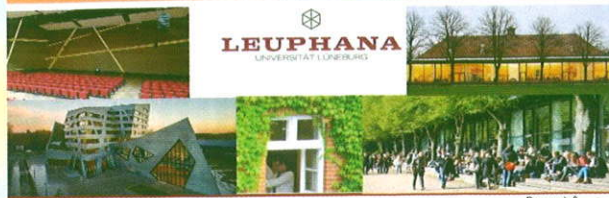
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## Oriented on Innovation & Sustainability

### Issues Instead Subjects

4 Scientific Initiatives: Economy, Education, Cultural Studies, Sustainability  
10 000 Students, College, Graduate School, Professional School



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## Faculty of Sustainability

### Sustainable Transformation to Sustainability

- **Interdisciplinarity – Transdisciplinarity**
  - **Social basis of society**  
(learning // management // governance)
  - **Physical basis of society**  
(biotic // abiotic) -> **Chemistry**

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## Capacity Building



Sustainable Chemistry and Pharmacy is an interdisciplinary and transdisciplinary journal. It publishes research that is related to chemistry or pharmacy on the one hand and sustainability on the other.

First Impact Factor in 2019: 2.4  
in 2020: 3.3  
in 2021: > 4.2 (expected)

Editor-in-Chief and Founding Editor:  
Klaus Kümmerer

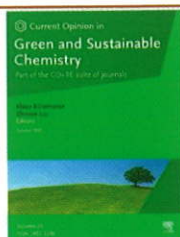
<https://www.journals.elsevier.com/sustainable-chemistry-and-pharmacy/>

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## Capacity Building



Evaluations of the most interesting papers, annotated by experts, from the great wealth of original publications.

Brief and timely review articles (> 10 pages)

First Impact Factor in 2020: 5.2  
in 2021: > 7 (expected)

Editor-in-Chief and Founding Editor: Klaus Kümmerer Co-Editor: Zhimin Liu, Chinese Academy of Science

<https://www.journals.elsevier.com/current-opinion-in-green-and-sustainable-chemistry/>

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### Upcoming events and activities:



Online format

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## Summer School on Sustainable Chemistry for Sustainable Development

Next: July 2021 (Bioresources)



6th Summer School on Sustainable Chemistry for Sustainable Development: 21.09.20 - 25.09.20

### Sustainable Chemistry and Water

<https://www.leuphana.de/en/institutes/isec/summer-school-sustainable-chemistry/summer-school-2020.html>

On-line

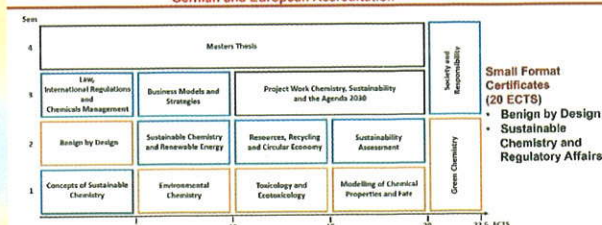
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## 2 - Year Curriculum (90 ECTS)

German and European Accreditation



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## M.Sc. Sustainable Chemistry

### Target Group:

International Professionals with a University Degree in Chemistry (or Related Field)

International Teaching staff (academia, authorities, industry)

### Mode of Study:

Mostly Online (Moodle for Remote Learning, Zoom for Live Sessions)

3 Onsite Sessions at Leuphana University

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## PROFESSIONAL MASTER IN SUSTAINABLE CHEMISTRY (M.Sc.)

CHEMISTRY - SUSTAINABILITY - SUSTAINABLE DEVELOPMENT

- Unique extra occupational expert interdisciplinary training
- 26/27 June 2020: On-Line Information Day
- 4 December 2020: On-Line Information Day
- 31 January: Application deadline
- March 2021: start next cohort
- [www.leuphana.de/sustainable-chemistry](http://www.leuphana.de/sustainable-chemistry)

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Prof. Klaus Kümmerer, Programme Director  
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[www.leuphana.de/sustainable-chemistry](http://www.leuphana.de/sustainable-chemistry)  
[www.leuphana.de/en/professional-school.html](http://www.leuphana.de/en/professional-school.html)



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