



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

# CIRCULAR ECONOMY FOR THE ENERGY TRANSITION: EXPERIMENTAL, THEORETICAL, AND METHODOLOGICAL TOOLS

PADOVA, FIORE DI BOTTA COMPLEX  
30th June - 04th July 2025

## MAIN TOPICS:

- THE DECARBONISATION CHALLENGE AND THE ENERGY TRANSITION;
- GHG MITIGATION AND CIRCULAR ECONOMY;
- RENEWABLE ENERGY SOURCES;
- CRITICAL RAW MATERIALS (CRM);
- USE OF BIOMASS AS A RENEWABLE SOURCE OF ENERGY AND MATERIALS;
- TWIN TRANSITION IN DIGITAL INFRASTRUCTURES (DATACENTRES);
- LCA, DESIGN OF EXPERIMENT, MACHINE LEARNING.

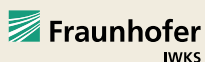
[unipd.it/en/circular-economy-energy-transition](https://unipd.it/en/circular-economy-energy-transition)

[summerschool@unipd.it](mailto:summerschool@unipd.it)

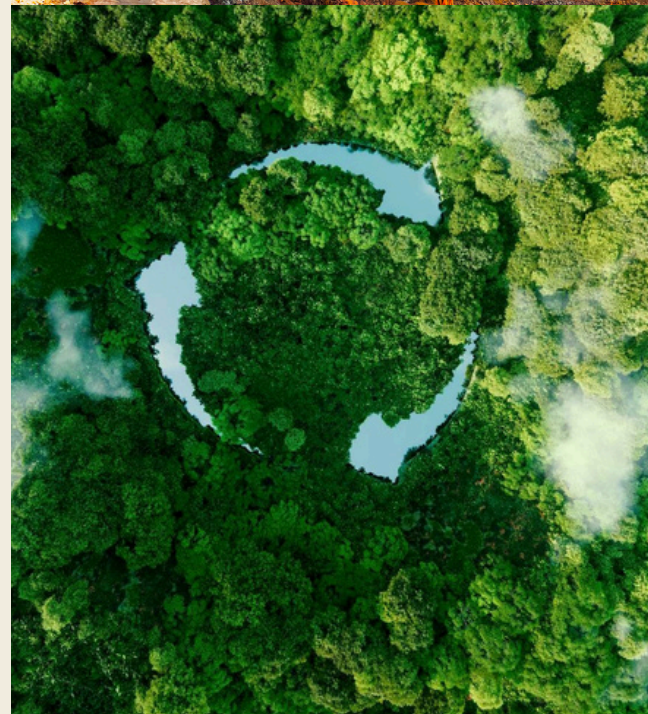
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## TIMETABLE

	30/06/2025	01/07/2025	02/07/2025	03/07/2025	04/07/2025
08:00 - 08:30	Registration				
08:30 - 09:00	Welcome Address				
09:00 - 09:45	Introduction to circular economy - <a href="#">Eleonora Di Maria</a> (University of Padua, Italy)	Sustainability and circularity in renewable energy systems through Life Cycle Assessment - <a href="#">Anna Mazzi</a> (University of Padua, Italy)	Photocatalysis for a clean environment- <a href="#">Urška Lavrencić-Stangar</a> (University of Ljubljana, Slovenia)	Simulating climate policy scenarios with EnRoads - <a href="#">Stefania Migliavacca</a> (Scuola Enrico Mattei, Rome, Italy)	Data Center Sustainability: the LCA VSIX - University of Padua - <a href="#">Marco Bettiol</a> (University of Padua, Italy)
09:45 - 10:30	Circular Chemistry for the energy transition - <a href="#">Silvia Gross</a> (University of Padua, Italy)	Critical raw materials and their strategic relevance in the energy landscape - <a href="#">Silvia Gross</a> (University of Padua, Italy)	Biomass as renewable source of energy and materials - <a href="#">Tomas Morosinotto</a> (University of Padua, Italy)	Simulating climate policy scenarios with EnRoads - <a href="#">Stefania Migliavacca</a> (Scuola Enrico Mattei, Rome, Italy)	Data Center Sustainability: the LCA VSIX - University of Padua - <a href="#">Marco Bettiol</a> (University of Padua, Italy)
10:30 - 11:00	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
11:00 - 11:45	Introduction to the energy transition I: Material demand for regenerative energy supply - <a href="#">Gert Homm</a> (Fraunhofer IWKS, Germany)	Integrated assessment modelling for the climate and the economy- <a href="#">Marta Castellini</a> (University of Padua, Italy)	The Lifecycle of Lithium-Ion Batteries: From Use to Reuse - <a href="#">Marco Fantin</a> (University of Padua, Italy)	Strategies for CO2 valorisation - <a href="#">Andrea Sartorel</a> (University of Padua, Italy)	Recycling of Data Center Components Using LCA Impact Indicators - <a href="#">Fernando Peñaherrera V.</a> (OFFIS Institut für Informatik, Germany)
11:45 - 12:30	Introduction to the energy transition II: Material demand for energy storage and conversion - <a href="#">Thomas Fischer</a> (Materials Alliance Cologne & University of Cologne, Germany)	Integrated assessment modelling for the climate and the economy- <a href="#">Marta Castellini</a> (University of Padua, Italy)	Introduction to hydrometallurgy for energy materials - <a href="#">Manuele Dabalà</a> (University of Padua, Italy)	Waste to energy supported by catalysis - <a href="#">Gabriele Centi</a> (University of Messina, Italy)	Recycling of Data Center Components Using LCA Impact Indicators - <a href="#">Fernando Peñaherrera V.</a> (OFFIS Institut für Informatik, Germany)
12:30 - 14:00	Lunch 90 mins	Lunch 90 mins	Lunch 90 mins	Lunch 90 mins	Lunch 90 mins

	30/06/2025	01/07/2025	02/07/2025	03/07/2025	04/07/2025
14:00 - 14:45	Thermodynamics for circular economy and the energy transition - <a href="#">Bernd Smarsly</a> (Justus Liebig University Giessen, Germany)	Mine waste as a perspective for CRM mining to address energy transition challenges: benefits and pitfalls - <a href="#">Matteo Ardit</a> (University of Padua, Italy)	FREE AFTERNOON	Novel recycling approaches and design for recycling of PV active materials and components - <a href="#">Klaus Müller-Buschbaum</a> (Justus-Liebig-University Giessen, Germany)	POSITION PAPER WORKSHOP - Discussion and proposal
14:45 - 15:30	Electrification and new business models in energy supply - <a href="#">Arturo Lorenzoni</a> (University of Padua, Germany)	Biogases at the Forefront: Securing Energy Supply and Accelerating the EU's Energy Transition - <a href="#">Pablo Molina</a> (European Biogas Association, Brussels, Belgium)		Emerging applications of Deep Eutectic Solvents (DES) in energy conversion and recycling of electrode materials <a href="#">Mauro Carraro</a> (University of Padua, Italy)	
15:30 - 16:00	Coffee break	Coffee break		Coffee break	Coffee break
16:00 - 16:45	Hydrogen: the big shot - The introduction to hydrogen economy <a href="#">Vito Di Noto</a> (University of Padua, Germany)	Modelling of the future resource availability - <a href="#">Francesco Di Benedetto</a> (University of Padua, Italy)		Novamont biodegradable bioplastics - <a href="#">Alessandro D'Elcio</a> (Novamont, Italy)	POSITION PAPER WORKSHOP - Discussion and proposal
16:45 - 17:30	Recycling concepts for rare earth permanent magnets- <a href="#">Gert Homm</a> (Fraunhofer IWKS, Germany)	Human rights implications on CRM extraction - <a href="#">Gabriella Salviulo</a> (University of Padua, Italy)		Novamont biodegradable bioplastics- <a href="#">Alessandro D'Elcio</a> (Novamont, Italy)	
17.30-18.30	Circular Spritz-Welcome	Free evening		Networking event	

# ABSTRACTS

[Matteo Ardit](#)

University of Padua, Italy

## Mine waste as a perspective for CRM mining to address energy transition challenges: benefits and pitfalls

The global demand for natural resources is growing to the point that many countries now consider these raw materials critical. This extraction generates large volumes of waste, particularly tailings - a mixture of crushed rock and processing fluids left over from the extracted resource. Tailings often far exceed the volume of the extracted material and may contain hazardous contaminants. Proper management is essential to prevent contamination of water sources and ecosystems. This contribution explores the nature, risks, and environmental impacts associated with tailings, while also highlighting the potential benefits and pitfalls of considering them as a source of secondary raw materials.

*Matteo Ardit received his Ph.D. in Mineralogy and Crystallography from the University of Ferrara in 2012. He is currently Associate Professor at the Department of Geosciences at the University of Padova. His research activity is mainly aimed at understanding the structural properties of minerals and synthetic analogues, to provide the basis for the design of materials with enhanced properties and to understand structural dynamics under different chemical and physical conditions.*

[Mauro Carraro](#)

University of Padua, Italy

## Emerging applications of Deep Eutectic Solvents (DES) in energy conversion and recycling of electrode materials

Deep Eutectic Solvents (DES) are gaining attention for energy conversion and the recovery of critical materials from electronic and electrical waste. Their unique composition, including metal chlorides and hydrogen bond donors/acceptors, allows for tunable properties, offering a greener and cheaper alternative to conventional solvents and ionic liquids. In particular, DES dissolve metals and metal oxides, making them ideal for extracting valuable materials from used electrodes. They are also suitable for electrochemical applications due to their wide potential window, high conductivity, and thermal stability. This lesson will explore case studies in sustainable energy storage and metal recovery.

*Mauro Carraro holds a PhD in Chemical Sciences and is currently a full professor of Organic Chemistry. He actively participates in various local and international initiatives focused on green and sustainable chemistry education. His research interests encompass hybrid materials for catalysis, sustainable transformations, environmental remediation, and the application of deep eutectic solvents for waste valorization.*



## Marta Castellini

University of Padua, Italy

### Integrated assessment modelling for the climate and the economy

An overview of integrated assessment models (IAMs) of climate and the economy, which couple a climate module with that of economic growth, taking into account the negative externalities of climate change on the economy, to assess the optimal social cost of carbon under different temperature limit targets.

*Marta Castellini is Assistant Professor in Political Economy at the University of Padova in the Department of Economics and Management "Marco Fanno" in Italy and Researcher at the Fondazione Eni Enrico Mattei, in Milan, Italy. My research fields are Political Economy, Economic Policy, Environmental and Energy Economics, Economic Modelling. At the Department of Chemistry of Padova I am teaching Economics for the Circular Economy at the Master degree in Sustainable Chemistry And Technologies For Circular Economy.*

## Gabriele Centi

University of Messina and ERIC aisbl, Italy

### Waste to energy supported by catalysis

The lecture will introduce the role of waste recycling in the future chemical (and refinery) scenario and the role of catalysis to enable these technologies, going from future integrated chemical and energy refineries and the need to enable carbon circularity, to the new sustainable and resilient model of distributed production, with integration on local resources and thus enhanced circularity also at the local level.

*Gabriele Centi is a full professor of Industrial Chemistry at the University of Messina (Italy) and President of the European Research Institute of Catalysis (Belgium). Past-president of the International Association of Catalysis Societies (IACS). His interest are in the area of heterogeneous catalysis (thermo, phot, electro and plasma) and green energy and chemical processes.*

## Manuele Dabalà

University of Padua, Italy

### Introduction to hydrometallurgy for energy materials

In the lecture will be covered the hydrometallurgical techniques for the recovery of metallic materials used in the production of batteries and of other strategic or critical metallic materials for engineering applications. The comparison of advantages and disadvantages in the use of hydrometallurgical techniques and other methodologies will be made.

*Full professor of Metallurgy at the Department of industrial Engineering. Author of about 170 indicized publications in the field of metallurgy. Research interest in the field of metals production and recycling, treatments of metals and characterization of properties of metallic products.*

## Alessandro D'Elicio

Novamont, Italy

### Novamont biodegradable bioplastics

The presentation is aimed at providing an update insight of the state of the art of bioplastics and of their potential in transitioning to a development model capable of conserving resources. To this end, the “Novamont biodegradable bioplastics” has been structured to include a description of the families of biopolymers relevant at industrial level and their characteristics, an illustration of the logic behind the design of bioproducts from biopolymers, the collection of a series of case studies and applications of bioproducts within selected value chains.

*Alessandro D'Elicio is an industrial chemist and researcher at Novamont, specialized in the development and optimization of Mater-Bi biopolymer grades. Technical manager for mulch film applications based on biopolymers, with strong expertise in sustainable materials and agricultural solutions.*

## Francesco Di Benedetto

University of Ferrara, Italy

### Modelling of the future resource availability

The contribution aims at introducing the physical constraints in the primary supply of certain CRMs, and the general concepts of depletion. The need of modeling the future availability of the earth resources as well as the methods to achieve this information will be discussed.

*Francesco Di Benedetto is a full professor in Earth Resource at the University of Ferrara, FDB's expertise focuses on the spectroscopic characterisation methods (EPR, XAS, MS) applied to mineral sciences. The research activity is devoted to novel solution for emerging materials, toxicity assessment of mineral species, environmental mineralogy, depletion of the Earth Resources.*

## Eleonora Di Maria

University of Padua, Italy

### Introduction to Circular Economy

Introduction to the concept of Circular economy, its main principles and the reasons for shifting from linear to circular economy. New insights related to the transformation in manufacturing and consumption processes will be presented.

*Eleonora di Maria has a PhD in Organization and Business Management, Eleonora Di Maria is Full Professor of Business Management at the University of Padua and from 2020 President of the University Center for the Connectivity and the Services to the territory – VSIX. From 2022 she is Advisor for Public Engagement and and Knowledge Valorization (Third Mission and Territorial Relations – University of Padova). Since late 1990s she has been involved in and coordinated national and international projects related to digitalization of firms as well as circular economy and sustainability strategies.*

## Vito Di Noto

University of Padua, Italy

### $H_2$ the big shot for the sustainability and technology

Hydrogen represents a key solution to support a revolutionary energy system capable of integrating renewable sources and drastically reducing greenhouse gas emissions, thereby contributing to mitigating global warming. Fuel Cells (FCs) and Electrolyzers (ELs) are the pillars of this new clean energy paradigm, currently undergoing research, development, and implementation.

This contribution will first analyze the role of hydrogen in the energy transition, with particular attention to the European perspective outlined in the Green Deal and the European Union's strategies to combat climate change. It will then explore the development of the so-called “Hydrogen Economy,” focusing on the importance of FCs and ELs as foundational elements of this new energy system.

The current state and future prospects of hydrogen-based technologies will also be illustrated, with reference to key performance parameters, economic aspects, and implementation costs. The most recent European scenarios will be analyzed, including updates from the EERA Annual Strategy Meeting, the

implications of the “Fit for 55” package on gas and hydrogen, and negotiations related to the Renewable Energy Directive (RED). Finally, EU initiatives such as the European Hydrogen Bank and the Green Deal Industrial Plan will be discussed, with a focus on the legislative framework for a net-zero industry.

*Prof. Vito Di Noto is Full Professor of Electrochemistry for Energy and Solid-State Chemistry in the Department of Industrial Engineering at the University of Padova, Italy. He is a Fellow of the Electrochemical Society (ECS) and was the recipient of the Energy Technology Division Award of the ECS for his breakthrough approaches in the development of new electrolytes and electrode configurations for fuel cells, electrolyzers, and batteries.*

*He currently serves as Chair of the Publication Committee of the International Society of Electrochemistry (ISE) and is Past President of the Electrochemistry Division of the "Società Chimica Italiana". He has also made seminal contributions to the understanding of ion conduction in condensed phases. He has published 363 scientific papers and holds 31 patents. His h-index is 57 (11,241 citations) on Google Scholar and 55 (8,900) on Scopus.*

## Thomas Fischer

University of Cologne, Germany

### Introduction to the energy transition II: Material demand for energy storage and conversion

Small molecule activation using renewable energies is central to the ongoing energy transition for a carbon neutral future. This talk is the second part of a tandem talk and will focus on energy storage and energy conversion using electrochemical methods.

*Thomas Fischer is a senior scientist at the Institute of Inorganic Chemistry of the University of Cologne (GERMANY). His research interest centers around thin film fabrication using chemical vapor deposition methods for the fabrication of catalysts for small molecule activation using (photo)electrochemical methods.*

## Marco Fantin

University of Padua, Italy

### The Lifecycle of Lithium-Ion Batteries: From Use to Reuse

This talk explores the lifecycle of lithium-ion batteries, focusing on their journey from initial use to potential reuse and recycling. It highlights the challenges and opportunities in extending battery life, recovering valuable materials, and developing sustainable second-life applications. Emphasis is placed on the role of electrochemical processes and innovative recycling technologies in building a circular economy for energy storage.



*Prof. Marco Fantin, Associate Professor of Physical Chemistry at the University of Padova, specializes in electrochemistry, recyclable catalysts, and polymerization mechanisms. With over 70 publications and 5000 citations, he collaborates with top international researchers and industry partners like Toyota and Syensqo. He has received multiple awards, including the PMSE "Future Faculty Award".*

## Silvia Gross

University of Padua, Italy

### Circular Chemistry for the energy transition

Circular Chemistry has emerged in the last 10 years as an implementation of green chemistry within a circular framework. Starting from the pioneering works of James Clark, Klaus Kuemmerer, and Chris Sootweg, setting its principles and paradigms, it represents a new approach to chemical design and production.

### Critical raw materials and their strategic relevance in the energy landscape

An introduction to Critical Raw Materials and Strategic Raw Materials within the EU policy framework: criteria for definition, updated list, Critical Raw Materials Act and relevance of CRM/SRM for the energy transition, by detailing their role in different strategic technologies.

*Silvia Gross is currently Full Professor of Inorganic Chemistry at the University of Padova and has a second affiliation as a DFG Mercator Fellow at the Karlsruher Institut für Technologie (KIT). She studied Chemistry (1996) and in 2000 she was awarded the Ph.D. in Chemical Sciences at the University of Padova. In 2001 she got a Lise Meitner Postdoctoral Fellowship from the Austrian Science Foundation (FWF) and spent 18 months at the Technische Universität Wien. Since 2021 she coordinates the international Master degree "Sustainable Chemistry and Technologies for Circular Economy". Her current research activity, documented by about 200 scientific publications (h-index 41, Jan 2025), 5 patents, 1 book, is mainly focused on the green wet chemistry synthesis of crystalline inorganic colloids and nanoparticles and on sustainable mild approaches for metal recovery.*

## Gert Homm

Fraunhofer IWKS, Alzenau, Germany

### Introduction to the energy transition I: Material demand for energy storage and conversion

The transition of energy production towards a regenerative, de-centralized system will not only need different materials than the conventional way but also will need more materials and space. This talk is the first part of a tandem talk and will focus on materials and their demand for the energy transition.

### Recycling concepts for rare earth permanent magnets

Magnets based on rare earth elements are crucial for many future applications, e.g. in the mobility and energy production sector. Next to the different application fields, the talk will give an overview on the supply and sustainability as well as the challenges in different recycling concepts of these magnetic materials.

*Dr. Gert Homm works as Business Unit Manager Bioeconomy and Innovation Manager at Fraunhofer IWKS. He studied physics at the Justus-Liebig University of Gießen. In 2012 he received his PhD for his work about green thermoelectric materials. In the same year he started working at the 2011 new founded Fraunhofer Institution for Materials Recycling and Resource Strategies IWKS, where he was active part of many projects on the treatment and utilization of organic and inorganic material residues.*

## Urška Lavrencic Stangar

University of Ljubljana, Slovenia

### Photocatalysis for a clean environment

The focus is on immobilized photocatalysts for a variety of environmental applications, from self-cleaning surfaces to highly active films for water and air treatment. Some basic differences between immobilized and suspended photocatalyst particles are highlighted, followed by various synthesis routes and deposition techniques. Subsequently, in addition to photocatalytically active material such as titania, the multifaceted role of silica is presented.

*Urška Lavrenčič Stangar began her career at the National Institute of Chemistry, Ljubljana. She was a postdoc at the Vienna University of Technology. Then she joined University of Nova Gorica, where she did pioneering work in the field of photocatalysis for environmental applications in Slovenia. Since 2016, she has been Professor of Inorganic Chemistry at the University of Ljubljana and leads the national research program "Chemistry for Sustainable Development". Her expertise includes heterogeneous (photo)catalysis, wet chemistry synthesis of materials, materials characterization.*

## Arturo Lorenzoni

University of Padua, Italy

### Electrification and new business models in energy supply

The energy sector is changing fast, with the affirmation of small scale units and the disappearing of economies of scale. A new competition is made to traditional suppliers by the consumers themselves and energy supply is more and more a service. The need to decarbonize is pushing electricity as the main vector and the grid management is played now at the local level, with new roles of all the parties.

*Arturo Lorenzoni teaches Energy Economics and Electricity Market at the School of Industrial Engineering of the University of Padua. Electrical engineer (1991), PhD in Energy (1995), in 1992 he obtained a Master's degree in Energy and Environmental Economics. His scientific interests are centered on the theme of energy economics, sector regulation, investment analysis. From 2017 to 2020 he was deputy mayor of the Municipality of Padua. Since October 2020 he has been a regional councilor of Veneto.*

## Anna Mazzi

University of Padua, Italy

### Sustainability and circularity in renewable energy systems through Life Cycle Assessment

Life Cycle Assessment methodology is a robust tool to support ecoinnovation and circular strategies. The application of LCA in energy transition options will be introduced and examples and case studies will be discussed to underline the importance of life cycle approach also in case of renewable energies to minimize overall environmental impacts with multicriteria analyses.

*Associate Professor at the Department of Industrial Engineering (univ. of Padova), teacher of Life Cycle Assessment and Environmental & Safety Management, research activity focused on environmental impact assessment of recycling processes and sustainability optimization of circular innovation.*

## Stefania Migliavacca

Scuola Enrico Mattei, Rome, Italy

### Simulating climate policy scenarios with En-ROADS

This workshop is an interactive experience that helps participants explore climate solutions using a powerful simulation model. Developed by Climate Interactive and MIT Sloan, En-ROADS allows users to test policies and see their impact on global temperature, energy use, and emissions. The workshop is engaging,

science-based, and designed for all audiences. It empowers people to understand the big picture and make better decisions on climate

*Stefania Migliavacca is an economist specializing in energy and climate change, with over 20 years of experience in research and teaching. her work explores the complex interactions between economic systems, energy transitions, and environmental sustainability. She is passionate about using data, models, and communication to drive informed climate action.*

## Pablo Molina Rosillo

European Biogas Association, Brussels, Belgium

### Biogases at the Forefront: Securing Energy Supply and Accelerating the EU's Energy Transition

Biogases are playing an increasingly strategic role in securing the EU's energy supply while driving its transition towards climate neutrality. With 22 bcm of renewable gas already injected into the grid, and €27 billion in private investment expected by 2030, the sector is gaining significant momentum. By 2040, biomethane could cover over 80% of projected EU gas demand. This presentation explores the opportunities and challenges in scaling up biogases, and their essential role in Europe's energy resilience.

*Pablo Molina joined the EBA in September 2024 as a Technical and Project Officer. He is responsible for monitoring technological and market developments related to biogenic CO<sub>2</sub>, as well as support schemes within the industry and tracks the latest EU funding opportunities in the biomethane sector. Additionally, he is actively involved in a Horizon Europe project, focusing on biohydrogen production. Pablo has three years of experience in the biofuels sector, where he worked as an R&D Engineer on biodiesel and biogas projects. He holds a Degree in Chemical Engineering from the Polytechnic University of Valencia and a Master's Degree in Sustainable Chemistry and Technologies for the Circular Economy from the University of Padova.*

## Tomas Morosinotto

University of Padua, Italy

### Biomass as renewable source of energy and materials

Biomass offers a sustainable and renewable source of both energy and materials. Biomass applications are found in multiple sectors across energy, agriculture, and industry. The potential role of biomass in the transition to a circular bioeconomy and its limitations will be discussed.

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*Tomas Morosinotto, professor in Plant Physiology and Director of the Botanical Garden of the University of Padova.*

*Present research focuses on the study of photosynthesis in different organisms investigating how evolution shaped the regulation of this metabolic process going from algae, mosses and plants. Information from basic research is exploited to develop algal strains and plants with improved photosynthetic efficiency and biomass productivity.*

## Klaus Müller-Buschbaum

Justus-Liebig-University Giessen, Germany

### Novel recycling approaches and design for recycling of PV active materials and components

Recycling of critical resources from key technologies plays a major role in order to have a suitable supply chain for these technologies apart from primary resources. For the example of photovoltaics, the majority of recycled materials do not involve the active materials as state-of-the-art. The talk shows novel ways to chemically recycle this important materials with regard to known problems and resulting options of design for recycling.

*Klaus Müller-Buschbaum is the director of the Institute of Inorganic and Analytical Chemistry at JLU Giessen. Chair of Inorganic Chemistry at JLU Giessen. Chair of the chemical division of Solid-State-Chemistry and Materials Research of the German Chemical Society GDCh. Board member the the EuChemS division Solid-State and Materials Research.*

## Fernando Peñaherrera

OFFIS Institut für Informatik, Oldenburg, Germany

### Application of Criticality Based LCA Impact Indicators to Evaluate Recycling of Data Center Components

This talk presents the results of the assessment of the environmental benefits of recycling data center servers, focusing on materials labelled as "critical" by the European Union.

A life cycle model is built using real disassembly data and literature-based recovery processes. Impact is evaluated using indicators like greenhouse gas emissions, energy demand, and critical material depletion. Results show high mass gold recovery (up to 95%) is achievable, but a total recovery of other critical metals is lower when considering weighting of the recovery rates (22–41%). The findings support improved recycling strategies for critical materials in data center sustainability planning, and a requirement of better information quality for a broader development of recycling strategies.

*Fernando Peñaherrera is an experienced developer and researcher with a PhD in applied sciences, specializing in environmental sustainability and systemic resource optimization. Proven track record in*



*developing open-source models and tools for improving resource efficiency across mobility, buildings, industry, energy systems, and data centers. Skilled in interdisciplinary applied research bridging academia and industry, with a strong focus on life cycle assessment, smart grids, renewable energy integration, and electricity markets. International experience and leadership in collaborative research projects at the intersection of resource and energy engineering and digitalization.*

## Gabriella Salviulo

University of Padua, Italy

### Human rights implications on CRM extraction

The talk illustrates the impact that mining, particularly CRM, has on the respect for and violation of human rights. Data from the most recent international reports will be discussed.

2002- Associate Professor of Mineralogy University of Padua

2019-2022 Head of Human rights Centre Antonio Papisca Padova University

*Scientific topic: Study of the efficacy and efficiency of iron oxide nanoparticles for the removal of pollutants from water and soil. Role of mineralogy in metal release processes.*

*Human rights and extractive activities.*

## Andrea Sartorel

University of Padua, Italy

### Strategies for CO<sub>2</sub> valorization

I will discuss the current possibilities for carbon dioxide capture and reconversion. A brief overview of industrial processes will be given, while then focusing on emerging technologies including electrochemical and photochemical CO<sub>2</sub> reduction and fixation.

*Andrea Sartorel is full professor of organic chemistry at the department of chemical sciences of the University of Padova. His research interests deal with photoelectrochemical processes exploiting molecular based ingredients for applications in the sustainable transformation of small molecules and in organic synthesis.*

## Bernd Smarsly

Justus Liebig University Giessen, Germany

### Thermodynamics for circular economy and the energy transition

Next to issues such as criticality, abundance, pollution, toxicity, etc., a major issue in circularity in making goods and in the energy economy is the inevitable energetic cost and CO<sub>2</sub> footprint. Hence, in order to judge any large-scale chemical and energetic process in terms of sustainability, a profound knowledge about fundamentals of energy and energy conversion is important. The course will start with basics of energy and explain why thermodynamics and thermochemistry is both, necessary and helpful to evaluate sustainability of energy sources, transformation and storage.

*Bernd Smarsly is professor of physical chemistry at JLU Giessen. Within his research interests his group focuses on carbon materials for sodium ion batteries. His teaching comprises basics of sustainable energy technologies in courses such as "physical chemistry of the energy revolution".*